Expert Report

of

Charles M. Brendecke, Ph.D., P.E.

Prepared on Behalf of

Idaho Ground Water Appropriators, Inc.

In the Matter of

Distribution of Water to Various Water Rights

Held by or for the Benefit of

The Surface Water Coalition

December 30, 2005

Table Of Contents

List of Figures

List of Tables

Section 1

Introduction

Purpose of Report

This report has been prepared on behalf of the Idaho Ground Water Appropriators, Inc., (IGWA) in connection with the January 14, 2005, request for water rights administration and delivery of water made by the Surface Water Coalition. The Surface Water Coalition ("SWC") comprises the A&B Irrigation District ("A&B"), the American Falls Reservoir District #2 ("AFRD#2"), the Burley Irrigation District ("BID"), the Milner Irrigation District ("Milner ID"), the Minidoka Irrigation District ("MID"), the North Side Canal Company ("North Side") and the Twin Falls Canal Company ("Twin Falls"). The SWC entities divert surface waters of the Snake River between Neeley and Milner Dam.

The SWC request for administration and delivery of water ("Delivery Call") was served on the Director of the Idaho Department of Water Resources (IDWR) seeking curtailment of junior ground water rights that allegedly cause depletions of the Snake River and material injury to the SWC entities' water rights. The request was treated as a delivery call under the IDWR's Conjunctive Management Rules (IDAPA 37.03.11) and resulted in emergency orders beginning in mid-January, 2005. IGWA responded to these orders with a replacement water plan. Both sides challenged the emergency orders, thus setting in motion an administrative process that calls for submittal of expert reports by December 30, 2005, and a formal hearing before the Director.

Previous Documents Submitted by IGWA

The documents listed below have already been submitted by IGWA to the IDWR in this matter and in the matter of the Ground Water District's Application for Approval of Mitigation Plan for the American Falls Reach of the Snake River are incorporated herein by reference. Certain conclusions in these documents may, however, be updated to reflect additional information and data that has become available since they were produced.

- Ground Water Districts' Application for Approval of Mitigation Plan for the American Falls Reach of the Snake River, dated February 8, 2005
- Affidavit of Charles M. Brendecke, PhD, PE, dated March 23, 2005
- Errata to Affidavit of Charles M. Brendecke, PhD, PE, dated March 29, 2005
- Second Affidavit of Charles M. Brendecke, PhD, PE, Regarding Replacement Water Plan, dated August 5, 2005
- IGWA's April 29, 2005 Replacement Water Plan

- IGWA's May 23, 2005 Information Submittal Responding to May 6, 2005 Order Regarding IGWA Replacement Water Plan

- IGWA's June 3, 2005 Supplement to Information Submittal

This Report does not include detailed analysis or conclusive opinions concerning the Director's December 27, 2005, Second Supplemental Order Amending Replacement Water Requirements ("Second Supplemental Order"), which IGWA and its consultants have not had a sufficient opportunity to review. IGWA reserves the right to amend and supplement this report to incorporate additional analyses and opinions relevant to the Second Supplemental Order or any additional orders in this matter.

Organization of Report

This Report is organized into five sections, including this introduction. Section 2 discusses pertinent aspects of the basic surface and ground water hydrology of the upper Snake River basin. Section 3 discusses the water rights and historical water supplies of the SWC entities. Section 4 discusses the Eastern Snake Plain Aquifer (ESPA) and the Enhanced Snake Plain Aquifer Model (ESPAM). Section 5 discusses the principal Orders issued by the Director of the IDWR in this matter and IGWA responses thereto.

All Figures and Tables referenced in the Report appear at the back of the Report. They are followed by an Appendix.

A notarized verification of the contents and authorship is attached to the back of this Report.

Section 2

Hydrologic Setting

This Section describes the climatology, surface and ground water resources of the Eastern Snake River Plain, focusing on those aspects most germane to the water needs and supplies of the Surface Water Coalition entities.

Climate

The climate of the Eastern Snake River Plain (ESRP) is semiarid with the mean annual precipitation recorded at most weather stations ranging from 6 to 12 inches (Goodell, 1988). Precipitation is generally least in July and August, when temperatures are highest, and is fairly evenly distributed the rest of the year. Only a few areas receive sufficient precipitation for non-irrigated agriculture, and melting snows from the surrounding mountains provide a substantial portion of the water supply needed for cultivation of crops. Goodell (1988) reports that annual precipitation on the ESRP averages 5.8 million acre-feet (MAF). Figure 2-1 is a general location map of the ESRP showing, among other things, the location of selected climate stations.

Annual precipitation on the ESRP varies greatly from year to year, and there is some evidence of long-term cycles. Figure 2-2 (a-d) shows the variation in annual precipitation at four weather stations on the ESRP. From these figures it can be seen that annual precipitation can range from 33% to 200% of average. This suggests that annual precipitation on the plain could range from 2 MAF to 10 MAF.

Potential evapo-transpiration (ET) on the plain ranges from about 19 to 30 inches per year (Goodell, 1988) and generally shows less variability, on an inter-annual basis, than precipitation. Actual ET on irrigated lands is a function of crop type, precipitation and irrigation water supply. Actual ET on non-irrigated land is limited by the amount of precipitation (Goodell, 1988).

A commonly used measure of agricultural water supply conditions is the Palmer Drought Severity Index (PDSI; Palmer, 1965). The PDSI reflects current and precedent precipitation and temperature conditions, and regional constants such as water-holding capacity of soils. It is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. Negative values of the PDSI reflect drier-than-normal conditions and positive values reflect wetter-than-normal conditions. A value of -2.0 or lower is considered moderate drought, -3.0 or lower is considered severe drought, and values lower than -4.0 are considered extreme drought.

The National Oceanic and Atmospheric Administration (NOAA) divides the lower 48 states into 344 climate divisions for purposes of calculating the PDSI. The two climate divisions that encompass the ESRP are shown on Figure 2-3.

The most common criticism of the PDSI is that the index values are not comparable between diverse climatic regions (Wells et al., 2004). However in the case of the ESRP only two contiguous climate divisions, Idaho climate divisions 7 and 9, cover the entire area of interest. For the present purposes the PDSI is an appropriate index to reflect climatological conditions on the ESRP.

Figure 2-4 (a,b) shows the historical annual values of the PDSI for climate divisions 7 and 9. Prolonged periods of wet and dry conditions can be clearly seen in this figure, and the significant periods of historical drought can be readily recognized. From these charts it appears that the drought cycle beginning in 2000 is among the longest and deepest on record for both climate divisions.

Surface Water Resources

Natural Flow Hydrology

The Snake River is the dominant surface water feature of the ESRP. Figure 2-1 also shows the essential hydrography of the plain and the location of key stream flow gaging stations. The two main branches of the Snake River are the South Fork, which primarily drains the eastern side of the Teton mountain range and emerges onto the plain near Heise, and the Henry's Fork, which primarily drains the western side of the Teton Range and joins the South Fork near Idaho Falls.

Several smaller tributaries enter the Snake River from the south between Heise and Milner Dam. The largest of these are Willow Creek and the Blackfoot, Portneuf and Raft rivers. With few exceptions, tributaries from the mountains to the north of the plain flow out onto the plain and recharge subsurface water systems.

The natural flow at Heise is a commonly used indicator of surface water supplies in the upper Snake River basin. It is computed by correcting the gaged flow at Heise for upstream reservoir operations at Jackson Lake and Palisades (other upstream water uses are small and have only a minor effect on river flows). The U.S. Bureau of Reclamation (USBR) performs this natural flow computation on a daily basis and makes the results available over the internet via the Hydromet system.

Figure 2-5 shows the annual (water year basis) Heise natural flow since 1911 when record-keeping began. It can be seen that the natural flow of the Snake River is highly variable. It can range from 52 % to 165 % of its annual average value of 5.1 MAF. Historical snow-pack droughts can be readily seen in this natural flow record, since it primarily reflects runoff from the headwaters basin to the east of the ESRP.

An analysis of historical droughts based on the Heise natural flow record was undertaken by the IDWR (Ondrechen, 2004). Among the findings of this analysis were that the driest 2-, 3-, 4-, and 5-year sequences on record were those occurring in the 2000-2004 period. This analysis used concepts from the theory of runs (Millan and Yevjevich, 1971) to conclude that the drought of 2000-2004 was approximately a 1-in-100 year event.

Figure 2-6 presents a comparison of the 5-year drought of 2000-2004 with the worst 5 years in the two preceding major drought cycles, 1931-35 and 1988-92. The droughts are compared in terms of Heise natural flow (accumulated deficit below average) and PDSI (median value for period). From these comparisons, it can reasonably be concluded that the drought of 2000-2004 has been the worst on record. In particular, it is worse than the 1930s drought period used in planning the storage supplies of the SWC entities.

Water Development

Development of surface water resources in the upper Snake River basin began in the late 19th century with the construction of privately-funded irrigation ditches and canals. This early development was concentrated on the Henry's Fork and upper reaches of the Snake River mainstem. Federal support of agricultural development, mainly via the Carey Act of 1894 and the Reclamation Act of 1902, led to construction of several large irrigation projects in the early part of the 20th century. This later development was concentrated further down the river, mainly between Neeley and Milner. As a result, surface water diversion rights in the upper reaches of the Snake River above Blackfoot tend to be senior to those in the lower reaches. Figure 2-7 (a-d), reproduced from Goodell (1988), shows the historical sequence of irrigation development on the ESRP.

The first major reservoir in the upper Snake River basin was created in 1906 by placing a dam on the natural outlet of Jackson Lake in Wyoming. This dam failed in 1910 and was subsequently replaced by larger dams eventually creating an impoundment of 847 thousand acre-feet (KAF). Numerous other irrigation reservoir construction projects followed. Table 2-1 lists the major irrigation reservoirs in the upper Snake River basin, along with their construction dates and present storage capacities.

Water diversions for irrigation led to substantial incidental recharge of the large basalt aquifer underlying the ESRP. This incidental recharge was the result of seepage and percolation of surface waters from leaky canals and farm fields.

Ground Water Resources

The ESRP is underlain by a vast basalt aquifer, the Eastern Snake Plain Aquifer (ESPA), formed when Quaternary lava flows filled ancestral canyons of the Snake River. In the central part of the ESPA these basalt formations extend to a depth of more than 3,000 feet (Whitehead, 1992). The agriculturally productive areas of the Plain occur in sedimentary and aeolian deposits overlying the basalts, which outcrop in numerous places. The porous and fractured basalt formations of the ESPA can store and transmit large amounts of water. Barraclough and others (1974) estimated that the ESPA may contain a billion acre-feet of water. Lindholm (1988) estimated that the upper 500 feet of the aquifer may contain 200-300 million acre-feet, an amount approximately 50 times greater than all the storage reservoirs above King Hill combined.

With the exception of shallow wells constructed in the Mud Lake area in the 1920s, ground water development of the ESPA did not begin in earnest until the late

1940s. The first federal irrigation project relying heavily on ground water supplies was the Minidoka North Side Pumping Division of the Minidoka Project (now the A&B Irrigation District) which began operation in 1948. Figure 2-8 shows the evolution of ground water permits for irrigation use on the ESRP based on data obtained from the IDWR. While the majority of these permits were for irrigation of new lands, many were for supplemental irrigation of lands already irrigated with surface water supplies. In addition, the benefits of sprinkler irrigation have led to the conversion of some formerly surface-water irrigated lands to ground water use. Ground water development began to level off in the 1980s and a moratorium on new irrigation well development has been in place since 1992.

The USGS carried out an extensive study of the ESPA in 1980 under its Regional Aquifer Systems Analysis (RASA) program; this study is summarized in Lindholm (1996). The RASA study concluded that total recharge to the aquifer in 1980 was approximately 8.0 MAF, more than 4.8 MAF (or about 60%) of which was incidental recharge from surface water irrigation (*ibid.*, p. 38). Natural recharge from precipitation, underflow from tributary basins and seepage from the Snake River were estimated to comprise approximately 2.8 MAF. Additional recharge of 0.4 MAF resulted from seepage from tributary streams and canals. Net ground water withdrawals in 1980 were estimated to be 1.14 MAF. So in 1980, the rate of annual ground water withdrawal was less than half the rate of annual natural recharge to the aquifer.

The USGS estimated that by 1952 more than 24 MAF of water had been added to the aquifer by incidental recharge (Kjelstrom, 1995). The importance of incidental recharge resulting from seepage losses from surface irrigation systems is evident in Figure 2-9 (a,b) which is reproduced from the RASA study. Figure 2-9 (a) shows the close correlation between incidental recharge and spring discharges in the Milner to King Hill reach of the river. The pattern of incidental recharge is clearly superimposed on a longer term increasing trend of spring discharge from 1912 to the mid-1950s, and is very closely related to the declining trend in spring discharge since the mid-1950s. Figure 2-9 (b) shows the estimated change in ground water storage from this incidental recharge.

Figure 2-10 shows the estimated annual discharge from the ESPA in the Thousand Springs Reach below Milner Dam for the period 1902-2005 using the methodology developed by Kjelstrom. While combined spring discharges have declined since mid-century, most acutely during drought periods, they are still, even after the current severe drought, greater than they were at the turn of the century before substantial irrigation began below Neeley.

The ESPA is hydraulically connected to the Snake River and its tributaries in several locations. The most dramatic of these connections is in the Thousand Springs Reach (TSR) between Milner Dam and King Hill mentioned above. Other connected reaches lie upstream of Milner Dam and where tributaries from the surrounding mountains meet the Plain.

Of particular importance to this report is the hydraulically connected reach between the near Blackfoot gage and the Neeley gage on the Snake River. This reach contains numerous springs estimated to discharge, in aggregate, roughly 2,500 cfs to the river. These spring flows provide the bulk of the gains to river flow between Blackfoot and Milner and form an important part of the water supply of the SWC entities.

The first published estimate of this reach gain was 1,830 cfs based on measurements made in August of 1905 (Stearns, *et. al.*, 1938). Systematic estimates of the reach gain began in 1912 and the USGS notes that the August gains in dry years increased steadily between 1905 and 1927 when American Falls Reservoir first filled. This increase was theorized to stem from irrigation development in the Aberdeen-Springfield area and on the Fort Hall tract (*ibid.*, pp 190-192). The annual reach gain over the 1912-1927 period averaged 2,480 cfs, and fell as low as 2,170 cfs in 1915.

The IDWR has prepared estimates of the near-Blackfoot to Neeley reach gain for the period 1928-2004. The average annual reach gain in this period is 2,680 cfs, further suggesting that upstream irrigation development may have enhanced these gains above their pre-development levels. Together with the single estimate in 1905, there is now a nearly 100-year record of the gains in this reach. Figure 2-11 shows reach gains systematically estimated by the USGS and IDWR for the period 1912-2004.

If ground water development on the ESRP were impacting this reach gain, it would be reasonable to expect the reach gain to show a declining trend since ground water development began. The reach gains shown in Figure 2-11 show no statistically significant trend over the ninety-three year period of record and no statistically significant trend between 1950, when substantial ground water development began, and the onset of the current drought in 2000 (*see Appendix A for detailed results of all statistical tests discussed in this reports*). What is also evident from Figure 2-11 is that the annual reach gain exhibits substantial variation from year to year, and that this variation was evident before ground water development began. As shown on Figure 2-12, there is no relationship between the annual reach gain and the accumulated rate of permitted ground water irrigation.

The annual near-Blackfoot to Neeley reach gain is, since 1928, significantly correlated with wet and dry climatic cycles as reflected in the PDSI. The relationship between the reach gain and PDSI is shown graphically in Figure 2-13. A similar relationship appears to exist between the observed flow of Spring Creek (a key index spring in this reach) and the PDSI, as shown on Figure 2-14. The foregoing relationships and analyses strongly suggest that reduced spring flows and reach gains observed over the period 2000-2004 were the result of drought conditions rather than ground water pumping for irrigation.

Another method for assessing whether there have been changes in hydrologic conditions between two points in a river system is double-mass analysis. This technique plots the accumulated flow at upstream and downstream points through time. Changes in the intervening flow regime, such as decreased reach gains, are evident as changes in slope of the double-mass line.

Figure 2-15 is a double-mass plot of the combined flow of the Snake River at the near Blackfoot gage and the flow of the Portneuf River versus the flow at the near Minidoka gage. If increasing ground water pumping over the 1950-1990 period were depleting the gains in this reach, the plotted line should veer increasingly to the right over that time period. However, there is no apparent change in slope of the double-mass plot over the 1950-1990 period of ground water development, which suggests that ground pumping has not reduced reach gains in the near Blackfoot to Neeley reach

Section 3

Water Supplies of the Surface Water Coalition

This Section describes the historical water supplies and water uses of the entities comprising the Surface Water Coalition, all of which divert from the Snake River below Neeley.

Natural Flow

Sources

When the irrigation projects below Neeley were developed in the early 20th century, they relied initially on diversions of the natural flow of the Snake River. The natural flow of the river below Neeley at the turn of the century is reflected in the gaged flow at Montgomery Ferry a few miles downstream from the present location of Minidoka Dam. The Montgomery Ferry gage was installed by the USGS in 1896, and until 1906 its record was affected only by diversions of the senior natural flow water rights diverting upstream of Neeley. In 1906 the flow at Montgomery Ferry began to be affected also by the operation of Jackson Lake and Minidoka Dams. The Montgomery Ferry gage was replaced by the "near Minidoka" gage in 1910. The gaged flow at Montgomery Ferry between 1896 and 1906 reflects the natural flow available to the SWC entities when they made their original appropriations, long before any effects of ground water development would have been manifest. Table 3-1 contains the monthly flows at Montgomery Ferry for the period of record of the gage.

Examination of the gage record at Montgomery Ferry reveals that 1905 was the driest year in the period between 1896 and 1906, though PDSI data indicate that it was not nearly as dry as years in subsequent drought cycles. The flows at Montgomery Ferry in 1905 are thus a reflection of drier-year natural flow supplies available to the SWC entities at the time of their original appropriations, and an illustration of the historical variation that has always existed in the natural flow available to them

As discussed in Section 2, senior natural flow water rights diverting above Blackfoot consume nearly the entire natural flow of the Snake River in dry years. In such years, the natural flow available to the SWC entities is mainly the reach gain that accrues to the river in the near Blackfoot to Neeley reach. Figure 3-1 shows the average monthly distribution of this reach gain for the period 1912-1948, a period before there could have been any significant impact on the gains from ground water development.

The substantial seasonal variation in these gains strongly suggests that they are influenced by upstream diversions and incidental recharge. The average irrigation season (April – October) reach gain over this period was 1.12 MAF. The peak month of this average reach gain occurs in July at approximately 2,725 cfs, which is a rate insufficient to satisfy even the most senior natural flow rights of the SWC entities.

The foregoing discussion makes it apparent that the SWC entities experienced substantial annual and season variation in their natural flow supplies well before the onset of ground water development.

Water Rights

The natural flow appropriations by the entities comprising the SWC are shown, in chronological order, in Table 3-2. Most of these appropriations have priority dates between 1900 and 1921. Also shown in the table is the accumulated amount of those natural flow appropriations.

Figure 3-2 is a graph of the daily flow of the Snake River at Montgomery Ferry in 1905 from records of the USGS (1950). Superimposed on this graph are the natural flow appropriation amounts of the SWC entities. It is evident from Figure 3-2 that the most junior of the natural flow rights of the SWC entities would have had access to natural flow for only a few days in 1905. By mid-July of 1905, only the senior (October 11, 1900) rights of North Side and Twin Falls would have been in priority, though from then on they would not have been able to divert at their full decreed amounts.

The analysis of Montgomery Ferry gaged flows demonstrates that the SWC entities holding more junior natural flow rights would have reasonably anticipated that those rights would have little or no yield in dry years, and that in such years even the most senior of the SWC natural flow rights would be unable to divert at their decreed amounts.

This conclusion is corroborated by comparison of the irrigation season gains data shown in Figure 3-1 with the accumulated natural flow rights of the SWC entities shown in Table 3-2. This comparison suggests that, even before the advent of ground water development, the SWC entities could never have expected their natural flow rights to be satisfied from reach gains arising below Blackfoot.

Historical Diversions

Natural flow diversions from the Snake River above Milner Dam have been systematically accounted and recorded by state water administration officials since 1919. In the early years these data were compiled in annual Water Distribution reports for Water District 36. Starting in 1971 they were published in annual Watermaster Reports for Water District 01.

In this accounting process, natural flow diversions are determined by subtracting storage diversions from observed total diversions. Initially, storage diversions were determined by manually routing storage releases down the river, deducting estimated losses, from upstream reservoirs to the canals calling for storage water. In 1977 this process was computerized and the calculations performed by what is now referred to as the Water District 01 "Accounting Model."

Data on historical water use by the SWC entities was excerpted from these historical reports and compiled into a spreadsheet. Figure 3-3 shows the annual natural flow diversions for each of the SWC entities from these historical records.

The annual natural flow diversions of the Twin Falls Canal Company since 1930 are excerpted and shown in Figure 3-4. 1930 was the first year that Twin Falls diverted more than one million acre-feet of water and the historical accounting records recite that 202,694 acres were irrigated under the canal in that year.

It is evident from Figure 3-4 that Twin Falls' natural flow diversions vary with wet and dry cycles, but there is no declining trend in these diversions since they reached what appears to be their full development level in about 1930. The average annual natural flow diversion for the period between 1930 and 1948, when ground water development on the Minidoka North Side Pumping Division (now A&B Irrigation District) began, was 847.8 KAF. There is no 19-year period in the 1930-2004 record in which Twin Falls has an average natural flow diversion less than what they diverted over this 1930-1948 period. This suggests that Twin Falls' natural flow supply today is as good as it was before ground water development began on the ESRP.

A similar analysis of historical natural flow diversions was completed for the North Side Canal Company. North Side first diverted one million acre-feet of water in 1925. There is no declining trend in their natural flow diversion and there is no 24-year period since 1948 when their average natural flow diversion was less than the average for the 1925-1948 period.

These findings regarding historical natural flow diversions suggest that ground water development on the ESRP has not discernibly reduced the amount of natural flow available to the SWC entities at the time they made their natural flow appropriations .

Storage Water

Reservoir Development

It was recognized early on by settlers in the area below Neeley that natural flow alone would not provide a reliable water supply for large scale irrigation and that reservoirs would be needed to supply storage water to supplement natural flow supplies. The U.S. Bureau of Reclamation's Minidoka Project was authorized in 1904 and provided the framework for most of the subsequent reservoir development in the upper Snake River basin. Table 2-1 lists the principal irrigation water storage reservoirs above Milner Dam and the year that reservoir operation began. Also shown on Table 2-1 are the current capacities of these reservoirs. The current capacity of Jackson Lake was not reached until 1916 after two enlargements of the original reservoir. The SWC entities do not have direct access to storage water supplies in Henry's Lake or Magic Reservoir (formed by Magic Dam).

Besides reservoir construction, the Minidoka Project included development of the irrigated lands now comprising the Minidoka and Burley Irrigation Districts, the A&B

Irrigation District and the American Falls Reservoir District #2 (AFRD#2), which was originally known as the Gooding Division of the Project. The Project serves as the primary water supply for the first three of these Districts. For AFRD#2 it provides the primary supply to 20,000 acres and supplemental water to 78,667 acres (Water and Power Resources Service, 1981, p.642)

With the construction of Palisades Reservoir in the late 1950s the four storage water supply facilities accessible by the SWC entities essentially reached their current capacity. The Palisades Project included a Winter Water Savings Program designed to enhance the yield of the project, which has a relatively junior water storage right. Under this Program, certain irrigation entities obtaining water from the project agreed to forego winter diversions they had historically made for stock water and domestic purposes under their more senior natural flow rights. In return for participating in the Winter Water Savings Program, these entites enjoy a more senior storage priority in Palisades and American Falls reservoirs than do other irrigation entities simply contracting for supplies from those projects.

Early Planning Studies

In 1946, the USBR published a Planning Report evaluating the potential water supply that would be generated by the Palisades Project (USBR, 1946). This report comprised a summary Regional Director's Report and an attached Substantiating Report containing the detailed findings underlying the report recommendations. By 1946, the Jackson Lake and American Falls reservoirs serving the SWC entities had essentially reached their current capacities. In the 1946 report, the combined operation of the two existing reservoirs (Jackson Lake and American Falls) and the proposed Palisades Project was simulated over a 1919-1942 hydrologic study period (a period prior to ground water development on the ESRP).

Two development plans were evaluated in these simulations. Plan A contemplated that no new land would be supplied with storage water from the Project, and that then-reserved space in American Falls would be contracted permanently to the SWC entities who had been using it on an interim basis since 1927. Plan B contemplated the development of new irrigated land under the Minidoka North Side Pumping Division and the Michaud Unit of the Fort Hall Project, a water supply project serving the Ft. Hall Indian Reservation. Under Plan B, the reserved space in American Falls was combined with the yield of the Palisades Project to help supply these new lands.

To a large degree, Plan B reflects the system configuration that was ultimately realized. The North Side Pumping Division was constructed and became the A&B Irrigation District. The Michaud Unit was constructed and became the Falls Irrigation District.

The Planning Report concluded that under Plan B, the entities diverting below Neeley and relying on the existing and proposed storage would have suffered water shortages of 803,000 af in 1934 and 157,000 af in 1935. These were presented as being 22% and 5%, respectively, of the demand in those years. Nevertheless, the report concluded that "Neither of these shortages would have caused serious crop loss" (ibid., p. 154).

The report explicitly discussed whether it would be desirable to avoid such shortages by foregoing the development of the new lands and devoting all the Project water supply to existing lands:

> *In view of the fact that a span of years as dry as those of 1931—1935 is likely to occur only once in a 50-year period, it is the conclusion of the report that the augmented water supply available for irrigation should be used in part for the development of new lands. Otherwise, surplus water will in nearly all years be wasted. (Substantiating Report, p 11)*

Based on this 1946 report, it is reasonable to conclude that in 1946, well before any significant ground water development on the ESRP, the SWC entities who rely on Jackson Lake, Palisades and American Falls Reservoirs anticipated that they could suffer water shortages of 20% in very dry years even with all three reservoirs fully operational.

In 1955, the USBR issued its Definite Plan Report for the Minidoka North Side Pumping Division (USBR, 1955). This report updated the Palisades Project operations studies of the 1946 Planning Report. It utilized a 1918-1947 study period (again, one that ends before ground water development on the ESRP really began) and assumed full operation of the planned North Side Pumping Division and the Michaud Unit. This updated operations study found that American Falls Reservoir would not have filled in any year of the 1932-1935 period, and that the Pumping Division (A&B Irrigation District) would have suffered shortages of 25% in 1935.

In 1969, the USBR carried out new operations studies of the reservoir system in connection with the American Falls Dam Replacement project (USBR, 1969). In these studies, the existing reservoir system (i.e., Jackson Lake, Palisades and American Falls) was projected to be empty at the end of the irrigation season in both 1934 and 1935.

These historical studies make it clear that the present system of reservoirs relied upon by the SWC entities was never designed nor expected to fill or prevent water shortages in very dry years. It is, therefore, reasonable to conclude that shortages in an extremely dry period, such as occurred in 2000-2004, were expected by the SWC entities regardless of the potential impact of future ground water development.

Storage Rights

The SWC entities obtain access to the water stored in Jackson Lake, American Falls and Palisades via spaceholder contracts with the USBR, which holds title to the water storage rights in the reservoirs. These contracts are for the yield of a defined amount of reservoir space and not for delivery of a specific amount of water. Table 3-3 lists the particulars of these spaceholder contracts, based on data contained in the Director's May 2 Order.

The spaceholder contracts are tied to the water right priorities of the reservoirs; for example, the spaceholder contracts in Jackson Lake fall into three different priorities. The priority preference enjoyed by Winter Water Savings Program participants causes there to be two contract priorities in American Falls and Palisades. Water is accrued to the contracted allotments of space as the reservoirs fill through the accounting procedures used by the IDWR. The reservoir storage rights fill in priority. Each contract allotment within a given priority fills at a rate proportional to its share of the total space in that priority until the first spaceholder allotment fills. Subsequent fill is proportioned among remaining spaceholder allotments until all are full or all storage inflow has been allocated.

The storage rights and accounting procedures permit storage exchanges "on paper" between reservoirs. This allows the system of reservoirs to be operated in an integrated way, balancing the advantages of storing water high in the basin and drafting last the reservoirs having the poorest likelihood of refill.

In the 1946 Planning Report discussed above, the operations analysis for Plan B showed all three reservoirs (Jackson Lake, Palisades and American Falls) would have been <u>empty</u> at the end of 1934. The system would have failed to fill in any of the four years 1932-1935. In contrast, at the end of 2004, the combined active storage in the three reservoirs was 476,600 af, and the combined carryover storage of the SWC entities was 288,300 af.

<u>Historical Yields of Spaceholder Contracts</u>

The accounting procedures for Water District 01 track the fill of all spaceholder contracts. In each annual accounting cycle there comes a date when storage accruals stop, either because all accounts are full or because runoff drops to a point where spaceholders begin to require storage water deliveries. At this point in time (typically in June or July) an initial storage allocation is determined for each spaceholder by subtracting anticipated seasonal evaporation from the accrued contents of each spaceholder account. Typically this evaporation deduction reduces the total amount of water allocated by a few percent.

Reservoir storage rights do occasionally come back into priority later in the irrigation season after diversion requirements have dropped off or during subsequent runoff peaks from precipitation events.

The yield of Jackson Lake and Palisades storage rights cannot be directly affected by ground water development on the ESRP because they fill from basins outside the plain. However, their yields could be affected by whether or not the more senior storage rights downstream in American Falls Reservoir have been filled, and Snake River flows below Heise that are tributary to American Falls are potentially affected by ground water development.

Because the system of storage reservoirs did not reach its current capacity until after ground water development began, it is difficult to directly assess how such development has affected the yield of storage rights held by the SWC. Some ground water development was in place on the ESRP by 1960, though the majority of ground water development was yet to occur.

The initial storage allocations of the SWC entities were extracted from historical accounting records. The initial allocations for the period since 1960, when the Palisades Winter Water Savings Program became fully operational, are shown in Figure 3-5. It can be seen from Figure 3-5 that the initial storage allocations of the SWC entities have been relatively steady since 1960. There is some variation from year to year reflecting the occurrence of dry years (reduced allocations between 1973 and 1977 were the result of construction work on American Falls Dam). Entities that are more heavily dependent on junior space in the reservoir system (e.g., A&B Irrigation District) have a somewhat more variable history of storage allocation than those entities relying more on senior space (e.g, American Falls Reservoir District #2).

The data presented in Figure 3-5 show that the storage supplies of the SWC entities are quite reliable, though not firm through the entire 1960-2004 period. This is precisely what was anticipated in the 1946 Planning Report for the Palisades Project, that storage water supplies would be reliable but not firm through drought periods. Figure 3-5 shows that in the dry year of 1961 initial storage allocations that year were substantially reduced. However, the 1961 allocations were similar to those of subsequent dry periods occurring after most ground water development was in place.

There are no significant declining trends in the initial allocations shown in Figure 3-5, such as might be expected if ground water development occurring since 1960 (and this is the majority of it) did have a substantial effect on these storage supplies. The small apparent declines in allocations to AFRD#2 and Twin Falls are the result of their being regularly allocated an amount greater than their spaceholder contract until the mid-1970s; this is clearly evident in Table 3-4, which shows the historical allocations as a percent of contract amount. Table 3-4 also shows that since 1960, the initial storage allocations of the SWC entities have averaged 89% of their contracted space, and that the contracted space has filled in most years.

The lack of declining trends in storage allocations is consistent with the lack of statistical evidence of ground water impact on observed reach gains in the near Blackfoot to Neeley reach that encompasses American Falls Reservoir.

Historical Water Bank Activity

Table 3-5 summarizes historical water bank activities of the SWC entities since 1960. While the District 01 Water Bank was formally organized in 1979, water bank-like leasing of storage supplies had been going on among upper basin water users for many years prior. Absent direct data concerning actual annual on-farm and service area-wide water requirements for the individual SWC entities, the record of such leasing activities is a reasonable indicator of whether those entities perceived their storage supplies to be more or less than adequate in any given year.

The table shows that since the formal adoption of the water bank in 1979, many of the members of the Surface Water Coalition have been regular contributors to the bank, a behavior which suggests they believed they had excess supplies in most of those years.

Ground Water Supplies

In addition to natural flow and storage water supplies, ground water supplies are available to water users served by some of the SWC entities. Figures 3-6 through 3-12 show permitted places of use of ground water rights falling inside of areas being claimed as irrigated by SWC entities in their SRBA submittals.

The Conjunctive Management Rules (Rule 42) state that the Director shall consider other sources of water available to senior surface water users in determining whether those users are sustaining material injury. Figures 3-6 through 3-12 show that nearly 75,000 acres claimed by the SWC entities in the SRBA have at least supplemental ground water supplies. The Director's Order of May 2 does not explicitly consider these supplies.

Historical Head-gate Deliveries

Historical head-gate deliveries to canal company shareholders were considered by the Director in determining the injury criteria articulated in the May 2 Order. The discussion below briefly describes historical deliveries and delivery policies of the SWC entities.

The term "head-gate delivery" refers generally to the amount of water made available by a canal company or irrigation district at the turnouts of its shareholders. In response to an information request from the Director, several of the SWC entities provided data on their head-gate deliveries since 1990. These are summarized in Table 3-6. Some of the SWC entities provided head-gate deliveries in terms of volumes of water delivered while others provided head-gate deliveries in terms of the flow rate made available. The latter was expressed as miners inches, where one miners inch is equivalent to 0.02 cfs. Neither Minidoka Irrigation District nor Burley Irrigation District provided head-gate delivery data in their response to the Director.

An effort was made, through research and discovery, to ascertain the formal water delivery policies of the SWC entities. While all of the entities had formal policies regarding the ordering and shutoff of water deliveries, not all had clear statements of what was considered a "full" or "normal" delivery to shareholders. The discussion below summarizes the known aspects of SWC water delivery policies as they relate to delivery quantity.

The A Unit of the A&B Irrigation District diverts natural flow and storage water from the Snake River via a pumping plant. The District normally allots 3 acre-feet per acre to each of its A-Unit user accounts (A&B, 2002). Deliveries beyond this amount are billed an excess delivery charge. A delivery requirement of 3.25 acre-feet per acre was assumed in the 1955 Definite Plan Report for the Minidoka North Side Pumping

Division. Applying the latter quantity to the 12,830 acres planned in the 1955 report gives a total head-gate delivery requirement of 41,700 acre-feet.

Milner Irrigation District operating policy limits deliveries to 4 acre-feet per acre (Milner ID, 1998) and assesses a surcharge on uses exceeding this amount.

American Falls Reservoir District #2 states in its Water Management Plan (2002) that water is allotted to the Magic Reservoir portion of the project area on the basis of 5/8 of a miners inch per acre, and that a similar rate is allotted to the American Falls Reservoir delivery portion of the project "on a continuous basis when the storage of American Falls Reservoir is full."

The North Side Canal Company delivers water to three "segregations" that were defined as the project was developed. The first segregation comprises approximately 28,000 acres and enjoys water delivery priority over the second and third segregations, which together comprise approximately 113,000 acres (North Side, 2003). Payment of O&M assessments entitles water users to 5/8 of a miners inch per acre, regardless of segregation. However, in times of shortage, deliveries are cut from the second and third segregations before they are cut from the first segregation.

The Twin Falls Canal Company Operation Policy (1998) states that the TFCC water right is 5/8 of a miner's inch per share. In their 1999 Water Management Plan, the Company states that the system was planned and constructed to deliver 1 cfs per 80 acres (this converts to 5/8 of a miners inch per acre). This is consistent with the findings of the 1912 Idaho Supreme Court case of *State v. Twin Falls Canal Company*. Furthermore, testimony of Canal Company officials (deposition of Jay Barlogi, p.20) is that canal breaks and other operational problems are more difficult to control at a delivery rate of ¾ inch. Nevertheless, Twin Falls has asserted in this Delivery Call proceeding that a full head-gate delivery in their system is ¾ of a miners inch.

Comparison of these delivery criteria with the historical head-gate deliveries shown in Table 3-6 suggests that the SWC entities are only occasionally unable to deliver full supplies. The only years listed in the table showing less than full head-gate deliveries are the years associated with the significant droughts commencing in the late 1980s and in 2000.

Section 4

Ground Water Modeling

This Section briefly describes the ESPA Ground Water Model and certain findings generated by the development and use of that model.

General Description of ESPA Model

The IDWR has developed several ground water models of the ESPA over the last 30 years, each one representing an improvement over its predecessor. The model described herein is the most recent one. It was developed over about a four year period beginning in the fall of 2000 by the Idaho Water Resources Research Institute (IWRRI) under contract to the IDWR.

The IWRRI has prepared extensive documentation of this model which is available on their website (www.if.uidaho.edu/%7ejohnson/FinalReport.pdf). In this documentation the model is referred to as the Eastern Snake Plain Aquifer Model (ESPAM). The discussion below is a synopsis of key features of and findings from the model; it presumes some familiarity with ground water modeling practice and terminology. The reader is referred to the model documentation and any of several comprehensive texts on the subject of ground water modeling (e.g., Charbeneau, 2000; Anderson and Woessner, 2002) for more detailed information.

Model Structure

The ESPAM is a finite-difference model based on the USGS' MODFLOW computer code (McDonald and Harbaugh, 1988; Harbaugh, et.al., 2000). The model domain is generally the Eastern Snake River Plain from King Hill on the west to Ashton on the east, and from the Snake River on the south to the lower ends of tributary valleys of the Wood and Lost river systems on the north.

The model grid contains 21,736 cells, each 1 mile square. Of these, 11,451 are active cells. Connections to tributary basins and to the Snake River are represented by constant flux boundaries, by river cells and by drain cells. The ESPAM is a single-layer model. Figure 4-1 shows the grid cell structure of the ESPAM and the types and locations of its hydraulic boundaries and connections to the Snake River.

Development Process

The ESPAM was developed primarily by researchers at IWRRI and by IDWR staff. An oversight committee, the Eastern Snake Hydrologic Modeling Committee ("Committee"), met periodically throughout the development period to review intermediate work results and to discuss the direction of future efforts. The Committee included consultants serving as technical representatives of the SWC, ground water users and spring water users. The development process was open and transparent, and input from and consensus among Committee members concerning modeling assumptions and direction was actively sought and considered by the model developers.

The model was calibrated to observed ground water levels and river reach gains on the ESRP over a 22-year period from May 1980 to April 2002. This transient calibration was accomplished using an automated parameter estimation program called PEST. PEST incrementally adjusts model parameters (mainly the transmissivity and storage coefficient in each model cell) with the aim of minimizing differences between simulated and observed water levels and reach gains across the model domain.

The model uses alternating 6-month stress periods representing the irrigation and non-irrigation seasons. The model time step used in calibration and in most simulations was one-tenth of a stress period, or 18.2 days. Model stress files were created using a Recharge Tool developed in a companion effort. The Recharge Tool assembles and processes various types of spatial and temporal data (e.g., irrigated acreage, crop type, precipitation, water right priority) and generates stress files for input to the ESPAM.

The completion of the calibration process in 2004 produced Version 1.0 of the ESPAM. This version was then used in a number of modeling scenarios and in some analyses underlying Orders issued by the Director. In late 2005 a new version of the ESPAM, v1.1, was released. This version reflects the correction of certain errors in calibration target data sets. As of the date of this report some but not all of the original modeling scenarios have been re-run using v1.1 of the ESPAM.

The ESPAM was developed using an approach that is generally consistent with commonly accepted modeling practice (e.g., Anderson and Woessner, 2002; ASTM, 2004). It is a reasonable representation of the aquifer system and is suitable for regional-scale analyses. There are certainly areas where further refinement is possible (see, e.g., IWRRI, 2005a, pp. 105-106), but at the present time the ESPAM represents the best available tool for quantifying the hydrological effects of water management activities in the ESPA.

Model Water Budget

An aquifer water budget consists of recharge and discharge terms. The difference between recharge and discharge over a given time period is the change in aquifer storage over that time period.

The components of recharge to the ESPA are precipitation; tributary underflow (subsurface water entering the aquifer from surrounding mountain drainages); seepage from rivers and streams; seepage from irrigation canals; and percolation of irrigation water from farm fields. The components of discharge from the ESPA are springs and river gains, and ground water pumping.

Figure 4-2 shows the ESPA recharge and discharge budgets in 1980 from the USGS RASA study (Lindholm, 1996). In 1980, aquifer discharge via ground water pumping was estimated to be 1.1 MAF and natural recharge (precipitation, tributary underflow, river and stream losses) was estimated to be approximately 3 MAF.

The ESPAM development effort included mass measurement of water levels across the ESRP in the spring and fall of 2001 and spring of 2002. It also included a comprehensive inventory of water uses on the ESRP over the model calibration period. This data was used to develop water budgets for each model cell and stress period. A summary presentation of the aquifer water budget is included in the draft model documentation. In this summary it is estimated that, over the 22-year calibration period, average annual aquifer discharge from ground water pumping was approximately 2.1 MAF and average annual aquifer recharge from natural sources was approximately 2.5 MAF (IWWRI, 2005a).

The importance of climatic variability to net aquifer recharge is illustrated in Figure 4-3 which is excerpted from the documentation of the revised Base Case Scenario (IWRRI, 2005b). The figure shows the net aquifer recharge for each year of the model calibration period and the annual precipitation at Aberdeen for the same period. While direct precipitation on the plain is not the only source of aquifer recharge, wet and dry climate cycles are strongly related to changes in the aquifer water budget.

This point is similarly made by Figure 4-4, which shows observed changes in aquifer water levels between spring 1980 and spring 2001, and between spring 2001 and spring 2002. Comparison of these two maps shows that in a single drought year aquifer water levels can change as much as they did over the preceding 22-year period. The IWRRI researchers concluded that between 1980 and 2001 the aquifer water budget was reasonably in balance (IWRRI, 2005a).

Findings of Key Model Scenarios

Several sets of model scenarios were identified by the Committee as being important to evaluating ESPA water management activities and changes. Among these were the following:

- Baseline Scenario – simulated the repetition of current climatic and water use conditions perpetually into the future
- Curtailment Scenarios – simulated the hypothetical curtailment of ground water pumping junior to selected priority dates
- Managed Recharge Scenarios – simulated recharge of the ESPA using existing canal systems
- No Changes in Surface Water Practices Scenario – simulated effects of increased conservation in surface water uses

The assumptions and results of these scenarios are also documented in detail on the IWRRI website. Results of the Base Case and Curtailment Scenarios are discussed below.

Base Case Scenario

In this scenario, the model inputs (stress files) from the final calibration run were appended end-to-end to simulate the repetition of calibration-period climatic and water use conditions out into the future. The principal aim of the scenario was to evaluate the degree to which the aquifer was in or near equilibrium.

This scenario has recently been re-run using v1.1 of the ESPAM. Results of this scenario for the near Blackfoot to Neeley reach are depicted in Figure 4-5. This figure shows that, under the climatic and water use conditions prevalent over the 1980-2001 period, reach gains were near a point of dynamic equilibrium by the end of 2001. While they can be expected to vary with wet and dry climate cycles in the future, the long term average reach gain will remain fairly constant.

Curtailment Scenarios

The Curtailment Scenarios simulated the hypothetical curtailment of ground water irrigation rights junior to January 1st of the following years: 1870, 1949, 1961, 1973, and 1985. The 1870 curtailment date effectively represents complete curtailment of all ground water irrigation except that occurring under tribal rights and agreements (and thus considered exempt from curtailment). The other dates were selected for representative purposes and do not reflect the priority of any specific water right that might exert a delivery call. The principal aim of the scenarios was to illustrate the amounts and timing of reach gain effects that would stem from curtailment of ground water pumping.

Based on results from the original Curtailment Scenarios using v1.0 of the ESPAM (IWRRI, 2004), the complete curtailment of ground water pumping for irrigation would dry up 1.1 million acres of farm land and reduce consumptive use of ground water by 2.1 MAF per year (or about 2900 cfs on average).

The reach gain effects of curtailment would be distributed both spatially and temporally. Scenario results indicate that reach gains would increase in all connected river reaches and springs, though the effect would vary greatly from place to place. Reach gains would increase slowly over time, approaching steady state conditions only after decades of curtailment.

Table 4-1 summarizes curtailment results for an 1870 curtailment using Version 1.1 of the ESPAM. It can be determined from this table that at steady-state, after decades of curtailment of all ground water pumping on the ESRP, only 38% of the increased reach gain from this curtailment would appear in the near Blackfoot to Neeley reach. More than half of this steady-state reach gain would accrue above Blackfoot or below Milner Dam. In the first irrigation season, only 5% of the foregone ground water consumption would accrue to the near Blackfoot to Neeley reach. In the first year of curtailment, only 11% would accrue to the reach.

Usability of Reach Gains

Usability of reach gains is an important consideration in evaluating the potential curtailment of ground water pumping. All reach gains generated by curtailment will not accrue in a place or at a time where they can be used by the SWC entities. For example, reach gains accruing to the river below Neeley during the winter months would simply pass Milner Dam and leave the upper basin unused. Similarly, any winter gains that accrue above Neeley after American Falls Reservoir has filled would simply flow past Milner unused.

The IDWR investigated the issue of usability of reach gains using the ESPAM in conjunction with the Department's Planning Model. The Planning Model is a monthly continuous simulation model that represents the operation of all the major reservoirs and canals above Milner over a 1928-1992 study period. Reach gains from curtailment were calculated with the ESPAM and these results were used as input to the Planning Model. Two runs of the Planning Model were made, one with and one without the additional reach gain.

The reach gains used in this analysis were the steady state gains accruing between Shelley and Milner from curtailment of ground water irrigation rights junior to January 1, 1961, calculated using v1.0 of the ESPAM. The steady state value of this reach gain was 888 cfs. Curtailment to this priority date would dry up 664,300 acres of ground water irrigated land (IWRRI, 2004).

The results of this analysis are shown in Figure 4-6, which shows the flows passing Milner Dam from the two Planning Model runs. The lines corresponding to Study 106 reflect current conditions without the additional reach gain. The lines corresponding to Study 108 reflect current conditions with the additional reach gain. The two horizontal lines on the figure show the long-term average flows passing Milner Dam over the entire study period. The variable lines show flows passing Milner Dam in each year of the study period.

The difference between the two horizontal lines is the long-term average increase in flow passing Milner Dam from the additional reach gain. This increase is 846 cfs, which is 95% of the 888 cfs steady state reach gain. In other words, 95% of the reach gain from curtailment would pass Milner Dam unused because it could not be diverted or stored.

Significantly, this same basic problem was recognized in the 1946 Planning Report for the Palisades Project. That study concluded that it made more sense to bring new land into production than to devote the entire project yield to existing lands, because under the latter operation the water would "in nearly all years be wasted."

This analysis demonstrates that most of the reach gains that could be generated by curtailment of ground water pumping would be unusable by the SWC entities. This is because the majority of them would arise in other reaches (above Blackfoot or below Milner) where they would not be accessible and because a substantial portion of those that would arise between Blackfoot and Milner would do so when there was no demand and no place to store them. The IDWR analysis found that the average amount of reach gain not spilled past Milner would be 42 cfs, or approximately 33,600 af per year. At a typical diversion rate of 6 af per acre, this is sufficient to provide a surface water supply to about 5600 acres, or less than 1% of the area dried up by the curtailment. Therefore it would make far more sense, in terms of efficiency of water use, to mitigate any material injury caused by ground water pumping by making targeted deliveries of storage water to the SWC entities in the occasional dry year.

Section 5

Director's Amended Order of May 2

This Section discusses key aspects of the Director's Amended Order of May 2, 2005 ("May 2 Order"), relating to material injury and mitigation. The May 2 Order clarified certain findings of an April 19, 2005, Order, but did not change the substantive findings of the April 19 Order. The Director issued these Orders pursuant to the Conjunctive Management Rules (IDAPA 37.03.11).

Material Injury

The Conjunctive Management Rules establish factors and criteria that are relevant to evaluating whether the thresholds and findings of the May 2 Order are appropriate. For example, the Rules provide that in determining the quantity of water a senior water right is entitled to call for, the Director is to consider the "average annual rate of fill of storage reservoirs and the average annual carry-over for prior comparable water conditions and the projected water supply for the system." (IDAPA 37.03.11.42.01.g). The Rules also provide that in determining the quantity of water that must be provided to mitigate material injury "[c]onsideration will be given to the history and seasonal availability of water for diversion so as not to require replacement water at times when the surface right historically has not received a full supply, such as during annual low-flow periods and extended drought periods." (IDAPA 37.03.11.43.02.b).

The discussion below addresses each of these questions in the context of the above criteria.

<u>Injury Thresholds and Findings</u>

In the May 2 Order the Director established two threshold criteria for determining the degree to which pumping by junior ground water rights caused material injury to senior surface water rights of the SWC entities. The first criterion was an in-season diversion requirement determined as the "*...minimum supply...recently diverted...for full head-gate deliveries...*". The second criterion was a "reasonable carryover" requirement determined from analysis of storage carryover in previous drought years. Material injury was defined as the projected 2005 shortfall from these thresholds for each of the SWC entities. Table 5-1 lists these injury thresholds and the 2005 material injury projections for the SWC entities from the May 2 Order.

In developing these injury thresholds the Director relied on historical Water District 01 records of diversions and storage by the SWC entities going back only to 1990 and on information submitted by the SWC entities themselves. With respect to the latter, the Director relied heavily on representations by three of the SWC entities as to what they asserted constituted "full head-gate deliveries." Full headgate deliveries were defined by the American Falls Reservoir District #2 and the North Side Canal Company as the ability to deliver 5/8 of a miners inch per acre at their farm turnouts. The Twin Falls

Canal Company asserted that a full headgate delivery in their system was ¾ of a miners inch per acre.

Review of Methodology

While the Director's approach to determining material injury appears to have been done within the framework of the Conjunctive Management Rules, it raises three important issues: 1) whether the thresholds were properly determined, 2) whether the thresholds represent an improved water supply over what was historically anticipated by the SWC entities, and 3) whether the thresholds properly address actual irrigation water needs, i.e., do they bear a relationship to actual beneficial use requirements. The discussion below addresses each of these questions.

Were the thresholds properly determined?

The injury thresholds were based on a standard, developed by the IDWR, of "minimum amount recently diverted for full head-gate deliveries" and on representations made by three of the seven SWC entities (Twin Falls, North Side and AFRD#2) as to what constituted their full head-gate delivery requirements. The other four SWC entities did not indicate in their information submittals what they considered full deliveries to their users.

North Side and AFRD#2 represented that full head-gate deliveries were 5/8 of a miners inch. Twin Falls represented that a full head-gate delivery was ¾ of a miners inch. As discussed in Section 3, the 5/8 inch criterion represented by North Side and AFRD#2 is consistent with planning and policy documents of those entities. However, planning and policy documents of Twin Falls indicate that a full head-gate delivery there is 5/8 inch and not ¾ inch.

A review of the 1990-2004 delivery information submitted by Twin Falls reveals that head-gate deliveries of 5/8 inch occurred in 1994, 2002 and 2003. The minimum seasonal diversion among these three years occurred in 2002 and was 1,009,100 af. This compares to the threshold of 1,075,900 af contained in the Order. Thus, if the "minimum amount recently diverted for full head-gate delivery" is the appropriate standard and had been consistently applied to the 1990-2004 data provided by Twin Falls, the seasonal injury threshold would have been 66,800 af smaller than what was adopted in the May 2 Order.

It is possible that the seasonal injury thresholds for the SWC entities would have been even smaller had a longer historical period than 1990-2004 been considered.

Notably, adopting the 2002 diversion as the injury threshold for Twin Falls would put it in a similar frequency class as the other SWC entities. The seasonal injury thresholds for the other six SWC entities all fall in the 10th to 30th percentile range of their historical diversions. In other words, the thresholds would protect those entities in the lowest 10-30% of years. In contrast, the seasonal injury threshold for Twin Falls in the May 2 Order is the 50th percentile of their historical diversions; that is, the threshold would essentially eliminate all below-average years for Twin Falls. Using the 2002 diversion to define the threshold would protect Twin Falls in the lowest 18% of years, an outcome more consistent with the protections provided the other entities in the May 2 Order and more representative of Twin Falls' historical experience in drought periods before substantial ground water development.

Although the Conjunctive Management Rules provide that the availability of wells is a relevant factor in analyzing material injury (IDAPA 37.03.11.41.01.h) and the May 2 Order states that analysis of "total water supply" is relevant, the availability of alternative ground water supplies apparently was not considered in the Order. For example, as discussed in Section 3, nearly 75,000 acres of land claimed by the SWC entities in the SRBA have ground water irrigation rights associated with them. Even in the unlikely event that all of these rights are supplemental rather than primary, they would still represent a substantial alternative water supply that was not considered in the May 2 Order.

Assuming that the standard of "minimum amount recently diverted for full headgate delivery" adopted in the May 2 Order is appropriate one for determining a threshold injury value, the thresholds adopted in the May 2 Order do not appear to have been properly determined.

Do the thresholds represent an improved water supply?

The issue here is whether the approach and findings of the May 2 Order provide the SWC entities with a greater water supply than that which was available at the time of their original appropriations and that which was anticipated in the planning of their storage facilities (i.e., that they could have expected under similar climatic conditions before ground water development). The analyses of historical natural flow availability in Section 3 of this report reveal that the SWC entities have been at risk of natural flow shortages in dry years since the time their natural flow rights were appropriated. The review of historical project planning documents shows that the SWC entities also anticipated dry-year shortages in their storage water supplies even with the system of reservoirs they have today. These shortages to natural flow and storage supplies were anticipated well before any significant ground water development on the ESRP.

The 1946 operations study for the Palisades Project projected a 1934 water shortage of 803,000 af to diversion requirements below Neeley (which included the not-yet-constructed North Side Pumping Division). The report stated that this represented 22% of their demand (though it would not have adversely affected crop production). Thus the projected 1934 seasonal water delivery to these diversions, with the Palisades Project in place and operating, was 2,847,000 af. This compares to the combined minimum diversion requirement of 3,105,000 af from the May 2 Order. In other words, the minimum requirement from the May 2 Order is 258,000 af greater than the 1934 supply anticipated in the operations study, even though the drought analysis of Section 2 demonstrates that the 2000-2004 drought was more severe than the drought of the 1930s.

In the Second Supplemental Order Amending Replacement Water Requirements issued on December 27, 2005 ("Second Supplemental Order"), the Director found (Finding 17) that the SWC entities had diverted a total of 2,837,000 af during the 2005 irrigation season. This is essentially the same as the drought-year seasonal diversion of 2,847,000 af anticipated 60 years ago in the operations study for the Palisades Project.

The 1946 operations analyses of the Palisades Project predicted also that there would be no carryover storage at the end of 1934 in the four system reservoirs relied upon by the SWC entities (Jackson Lake, Palisades, American Falls and Lake Walcott). In contrast, the combined "reasonable carryover" threshold for the SWC entities established in the May 2 Order is 188,600 af and the actual 2005 carryover, according to the Second Supplemental Order, is 783,100 af.

The analysis of historical natural flow diversions presented in Section 3 show that the natural flow supplies of the SWC entities are as good or better now than they were before ground water pumping began. Yet the SWC entities seek curtailment of pumping to increase their natural flow supplies, and the May 2 Order appears to support this.

Based on a review of historical natural flows and original planning documents, it appears that the May 2 Order mandates that the water supplies of the SWC entities be improved over what was originally available to and anticipated by them under similar climatic conditions.

Do the thresholds properly reflect actual irrigation requirements?

The Order acknowledges that actual irrigation requirements vary from year to year based on climate, crop selection, irrigated acreage and other factors. However, the thresholds adopted in the Order are not based on determination of crop irrigation requirements and consider neither the actual nor the claimed irrigated acreage within the SWC service areas.

The 2005 irrigation season illustrates the degree to which the thresholds May 2 Order diverge from actual water needs. The cool, wet spring reduced irrigation demands substantially allowing all but the most junior storage priorities to fill. Neither the May 2 Order nor the Second Supplemental Order contain an analysis of such factors. Nor do they consider whether there are significant areas within the SWC entities' claimed service areas that are not irrigated (*see* Expert Report of Scott King, December 30, 2005) and how such areas would affect the diversions necessary to provide full deliveries.

Based on the foregoing, it is evident that the May 2 Order did not consider the actual beneficial use irrigation needs of the SWC entities in 2005.

Moreover, the availability and review of information regarding historical and projected water supplies from time periods preceding ground water development calls into question the use of the "minimum amount recently diverted for full head-gate deliveries" standard used in the May 2 Order. The Conjunctive Management Rules provide for consideration of "prior comparable water conditions" and whether the calling surface water right "historically has not received a full supply, such as during annual low-flow periods and extended drought periods." The historical information that is available from time periods preceding ground water development indicates that the SWC entities are really no worse off in the present drought than they were, and anticipated they would be, in the comparable water conditions of the 1930s. If the present supply conditions have such precedent, and it seems they do, it is reasonable to conclude that no mitigation should be required now from ground water users.

Mitigation

Requirements

In the May 2 Order, the Director used the ESPAM to determine that curtailment of all ground water irrigation rights in the ESPA junior to February 27, 1979, would, over time, generate 133,900 af of increased reach gain in the near Blackfoot to Minidoka reach of the Snake River. He further determined that curtailment of the junior ground water rights within organized Water Districts 120 and 130 would generate 101,000 af of this increased reach gain.

He ordered holders of all ground water rights affected by the Order to provide mitigation in the form of replacement water to the SWC entities or face curtailment of their pumping for the remainder of 2005. Any replacement water plan would be required to deliver a minimum of 27,700 af within the 2005 irrigation season...an amount equal to the predicted irrigation season shortfall of the SWC entities in 2005. The Director retained the authority to revise the mitigation requirements as the season progressed. On July 22, 2005, he issued a Supplemental Order Amending Replacement Water Requirements. The requirements were amended again in the Second Supplemental Order issued December 27, 2005.

IGWA Replacement Water Plan

On April 29, 2005, in response to the original April 19th Order, the Idaho Ground Water Appropriators, Inc. (IGWA) submitted a Replacement Water Plan addressing the mitigation requirements determined by the Director. Additional information submittals were made on May 23rd and June 3rd. On June 24, 2005, the Director issued an Order Approving IGWA's Replacement Water Plan.

The IGWA Replacement Water Plan identified a total of 87,145 af of water that was available to IGWA to meet its 2005 mitigation requirements. The bulk of this water was to be derived from an exchange of natural flow rights diverting from the Snake River below Milner. Other supplies were to be generated from leases and agreements with users above Milner, and from past and ongoing mitigation activities in Water District 130 (primarily voluntary curtailments). Table 5-2 lists the specific activities and amounts of replacement water offered in the IGWA Replacement Water Plan.

The Director's June 24 Order approving the Replacement Water Plan credited IGWA with a somewhat lesser amount of water than was offered, though substantially more than was necessary to meet the minimum obligation of 27,700 af. The Order failed, however, to recognize any replacement credit for mitigation activities undertaken in Water District 130, primarily voluntary curtailments by ground water users, even though ground water use in Water District 130 was held in the May 2 Order to have materially injured the SWC entities.

Bibliography

Anderson, M. P., W. W. Woessner. 2002. Applied Groundwater Modeling, Simulation of Flow and Advective Transport. Academic Press. Selected pages.

Barraclough, J.T., B.D. Lewis, and R.G. Jensen, 1981. Hydrologic Conditions at the Idaho National Engineering Laboratory, Idaho; emphasis 1974-1978. USGS Open File Report 81-526. 122 pages.

Big Wood Canal Company, and American Falls Reservoir District No. 2 with assistance from Idaho Water Users Association, Inc. and CH2M Hill. October 2002. Water Management and Conservation Plan. 60 pages.

CH2M Hill. November 1999. Twin Falls Canal Company Water Management Plan. 25 pages.

Charbeneau, Randall J. 2000. Groundwater Hydraulics and Pollutant Transport. Prentice Hall. 593 pages.

Corps of Engineers, North Pacific Division. May 1985. Project Data and Operating Limits. Columbia River and Tributaries Review Study. Report No. 49. 278 pages.

"Cosgrove Presentation to Legislative Subcommittee." August 5, 2004.

Figure 1, Irrigation System Inventory.

Goodell, S.A., 1988. Water Use on the Snake River Plain, Idaho and Eastern Oregon. U.S. Geological Survey Professional Paper 1408-E. 51 pages.

Harbaugh, A. W., E. R. Banta, M. C. Hill and M. G. McDonald, 2000. Modflow-2000, The U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process. USGS Open-File Report 00-92. Selected pages.

Kjelstrom, L.C., 1995. Streamflow Gains and Losses in the Snake River and Ground-water Budgets for the Snake River Plain, Idaho and Eastern Oregon. U.S. Geological Survey Professional Paper 1408-C. 47 pages.

Lindholm, G.F., 1996. Summary of the Snake River Plain Regional Aquifer-System Analysis in Idaho and Eastern Oregon. U.S. Geological Survey Professional Paper 1408-A. 59 pages.

McDonald, M. G., and A. W. Harbaugh, 1988. Techniques of Water-Resources Investigations of the United States Geological Survey. "Chapter A1, A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model".

Millan, J., and V. Yevjevich, 1971. Probabilities of Observed Droughts. Hydrology Paper 50. Colorado State University. 50 pages.

Milner Irrigation District Board of Directors. December 11, 1991, Revised April 16, 1998. Milner Irrigation District, Operating Policy. 16 Pages.

Milner Irrigation District, with assistance from Idaho Water Users Association, Inc. and CH2M Hill. April 2004. Water Management and Conservation Plan. 45 pages.

Newell, F. H., 1906. Report of Progress of Stream Measurements for the Calendar Year 1905. Dept. of the Interior, U.S. Geological Survey. Water-Supply and Irrigation Paper No. 178. Pages 91 to 96.

North Side Canal Company, Ltd. with assistance from Idaho Water Users Association, Inc. and CH2M Hill. December 2003. Water Management and Conservation Plan. 44 pages.

North Side Canal Company. December 18, 1992. Right-of-way Policy and Agreement for Sprinkler Installations. 11 pages.

Ondrechen, B., 2004. Examination of drought length and severity for ESRPA model studies. State of Idaho Department of Water Resources Memo dated October 29, 2004. 3 pages.

Palmer, W.C., 1965. Meteorological Drought. Office of Climatology Research Paper 45, Weather Bureau, Washington, D.C. 58 pages.

Processes Used by BID to Restrict Water Users in Dry Years. 26 pages.

Stearns, Harold T., L. Crandall, W. Steward. 1938. Geology and Ground-Water Resources of the Snake River Plain in Southeastern Idaho. U.S. Department of the Interior Water-Supply Paper 774. Selected pages.

Twin Falls Canal Company. December 10, 1997. Twin Falls Canal Company, Operation Policy. 16 pages.

USBR, Region 1. July 1969. Water Supply, Requirements, and Power Appendix, American Falls Dam Replacement, Idaho, Upper Snake River Project, Idaho-Wyoming. 67 pages.

USBR. February 1997. Milner Irrigation District, Water Management and Conservation Review. 34 pages.

USBR. October 1946. Water Supply for Palisades Reservoir Project, Idaho. Project Planning Report 1-5.17-1.

US Dept. of the Interior, Water and Power Resources Service. 1981. Project Data.

Wells, N., S. Goddard, and M.J. Hayes, 2004. A Self-Calibrating Palmer Drought Severity Index. Journal of Climate. Volume 17, Number 12. Pages 2335-2351.

Whitehead, R.L., 1992. Geohydrologic Framework of the Snake River Plain Regional Aquifer System, Idaho and Eastern Oregon. U.S. Geological Survey Professional Paper 1408-B. 32 pages.

Appendix A

(1) Near Blackfoot to Neeley trend test over the period of record.

(a) 1912-2004

Test: Linear regression test for slope=0. Student t-test.
Statistics:

pvalue	tvalue	tcritical
0.1063985	1.630755	1.986377

Intercept	Slope
0.3055500078	0.0008232701

(b) 1950-2004

Test: Linear regression test for slope=0. Student t-test.
Statistics:

pvalue	tvalue	tcritical
0.04159134	2.088298	2.005746

Intercept	Slope
6.813946255	-0.002465014

(c) 1950-1999

Test: Linear regression test for slope=0. Student t-test.
Statistics:

pvalue	tvalue	tcritical
0.6148128	0.5065167	2.010635

Intercept	Slope
3.1914121537	-0.0006237023

(2) Near Blackfoot to Neeley gains, and correlation with Idaho Climate Division #9 PDSI .

(a) 1912-2004

Kendall's rank correlation tau

z = 1.374, p-value = 0.08471
alternative hypothesis: true tau is greater than 0
sample estimates:

tau
0.09684212

Pearson's product-moment correlation

t = 1.4775, df = 91, p-value = 0.0715
alternative hypothesis: true correlation is greater than 0
95 percent confidence interval:
-0.01910664 1.00000000
sample estimates:
cor
0.1530614

(b) 1928-2004

Kendall's rank correlation tau

z = 2.6874, p-value = 0.0036
alternative hypothesis: true tau is greater than 0
sample estimates:
tau
0.2089246

Pearson's product-moment correlation

t = 2.2602, df = 75, p-value = 0.01336
alternative hypothesis: true correlation is greater than 0
95 percent confidence interval:
0.066801 1.000000
sample estimates:
cor
0.2525278

(3) Trend in initial storage allocation for SWC entities, 1960-2004.

Test: Mann-Kendall
Statistics:

SWC Entity	Kendall tau	pvalue
Minidoka ID	0.3320	0.0014539
Burley ID	0.4400	2.4199e-05
A&B ID	-0.1410	0.17958
Milner ID	0.1480	0.15585
AFRD #2	-0.3950	0.00014999
North Side	0.0265	0.80653
Twin Falls	-0.2400	0.024207

(4) Trend in Twin Falls natural flow diversion, 1930-2004.

Test: Mann-Kendall
Statistics:
tau = 0.243
pvalue =0.0020487

VERIFICATION

STATE OF COLORADO)
) ss.
County of Boulder)

CHARLES M. BRENDECKE, being duly sworn, on oath deposes and says that he has read the within and foregoing Expert Report of Charles M. Brendecke, Ph.D., P.E., knows and has prepared the contents of thereof, and believes the same to be true and correct.

Charles M. Brendecke, Ph.D., P.E.

SUBSCRIBED AND SWORN to before me this 30th day of December, 2005.

Carol McAmis
NOTARY PUBLIC in and for the State of Colorado

Residing at: 7988 Marshall Street, Arvada, CO 80003

My Commission expires: 12/2/08

VERIFICATION

STATE OF COLORADO)
) ss.
County of Boulder)

CHARLES M. BRENDECKE, being duly sworn, on oath deposes and says that he has read the within and foregoing Expert Report of Charles M. Brendecke, Ph.D., P.E., knows and has prepared the contents of thereof, and believes the same to be true and correct.

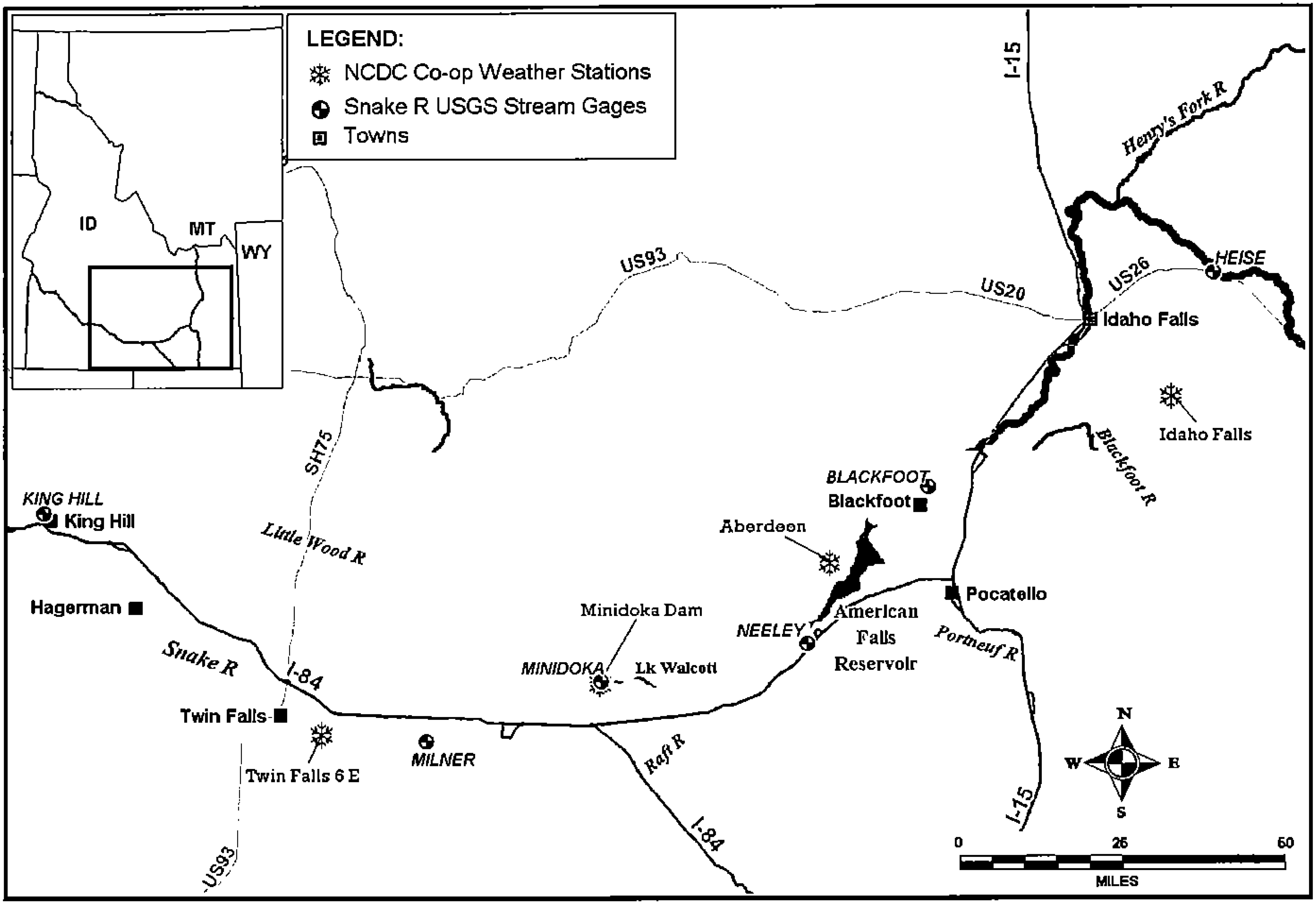
Charles M. Brendecke, Ph.D., P.E.

SUBSCRIBED AND SWORN to before me this 30th day of December, 2005.

Carol McAmis
NOTARY PUBLIC in and for the State of Colorado

Residing at: 7988 Marshall Street, Arvada, CO 80003

My Commission expires: 12/2/08

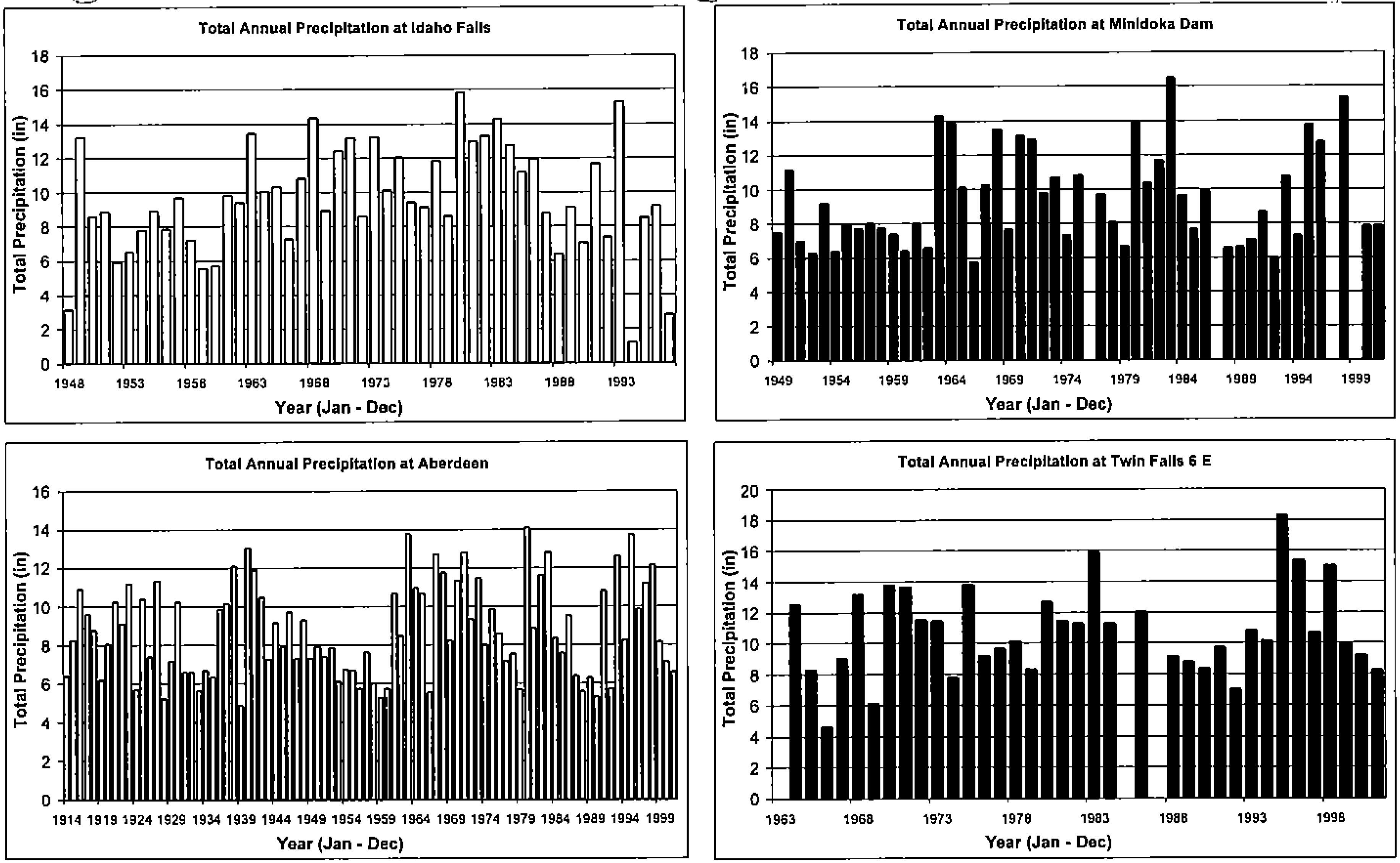


HYDROSPHERE Resource Consultants

December 2005

Figure 2-1

General Location Map – Eastern Snake River Plain



Source: NCDC Summary of the Day
http://www.ncdc.noaa.gov/oa/climate/stationlocator.html

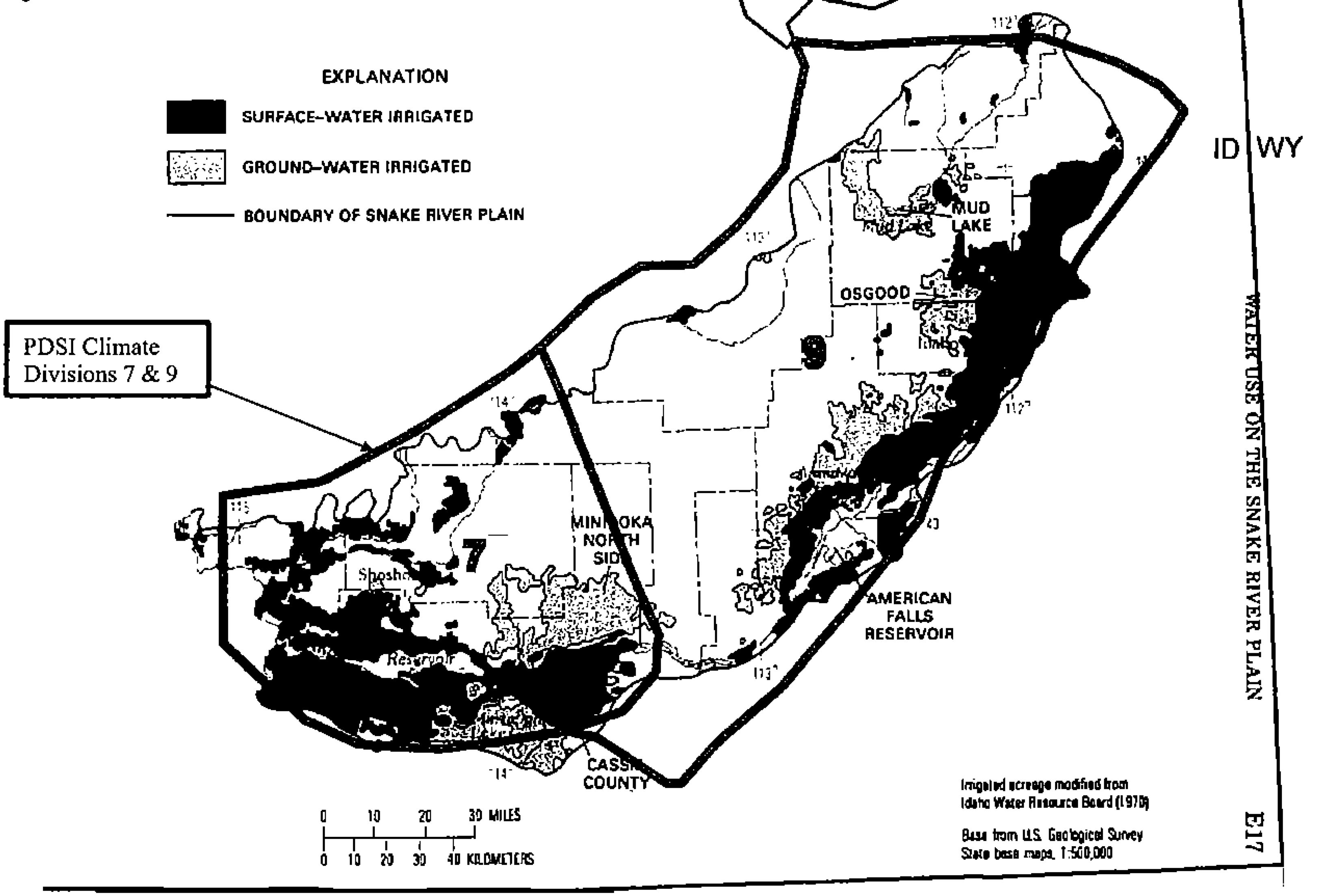
HYDROSPHERE
Resource Consultants

December, 2005

Figure 2-2

Annual Precipitation at Selected Weather Stations

Source: Boundaries for PDSI Divisions 7 & 9 from NOAA
(http://lwf.ncdc.noaa.gov/img/onlineprod/drought/id.gif)
Irrigated Areas from Goodell. 1988

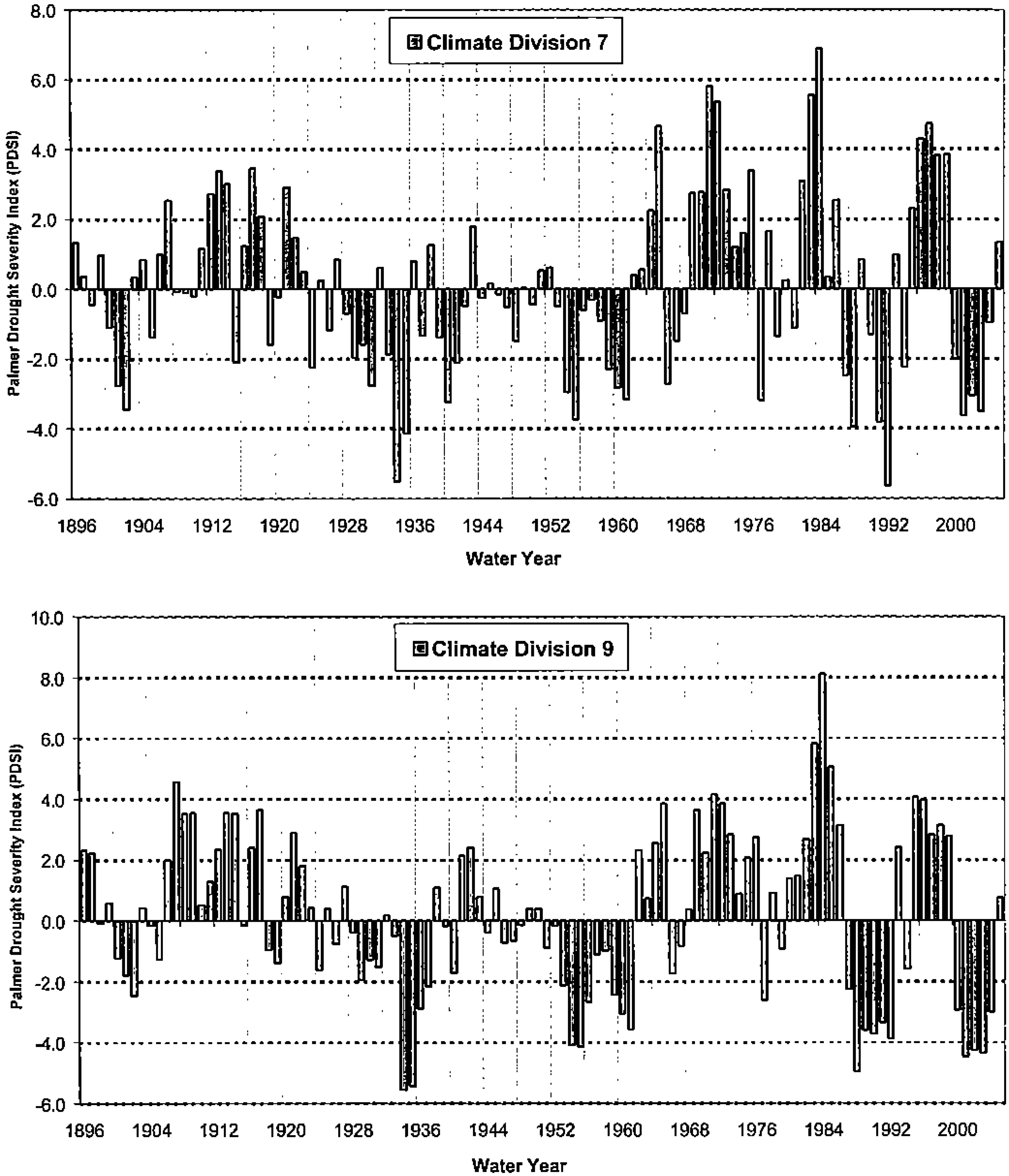


HYDROSPHERE Resource Consultants

December 2005

Figure 2-3

NOAA Climate Divisions on the Eastern Snake River Plain



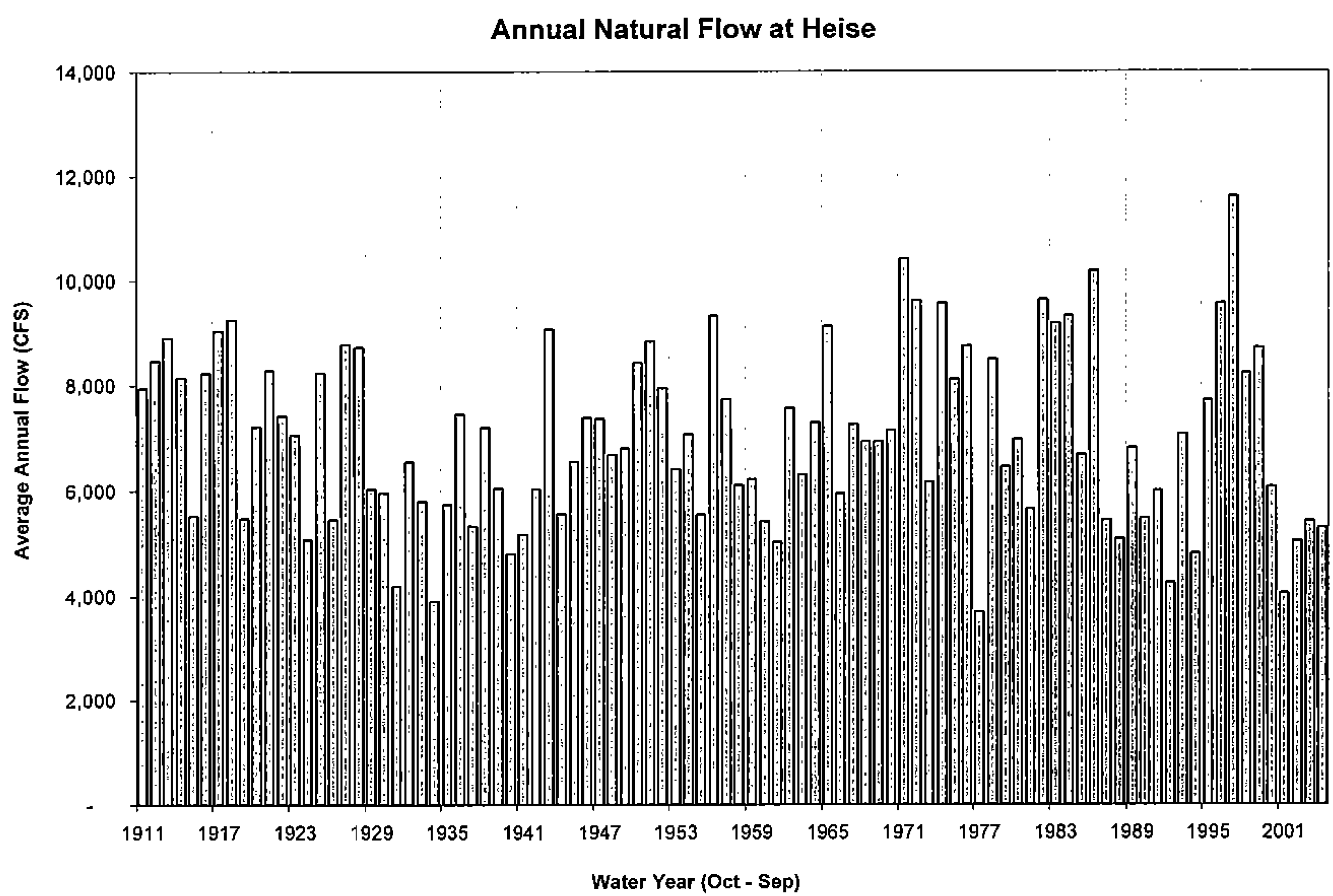
Source: NOAA
http://www.cdc.noaa.gov/cgi-bin/Timeseries/timeseries1.pl

HYDROSPHERE
Resource Consultants

December, 2005

Figure 2-4

Average Annual Palmer Drought Severity Index for Climate Divisions 7 and 9



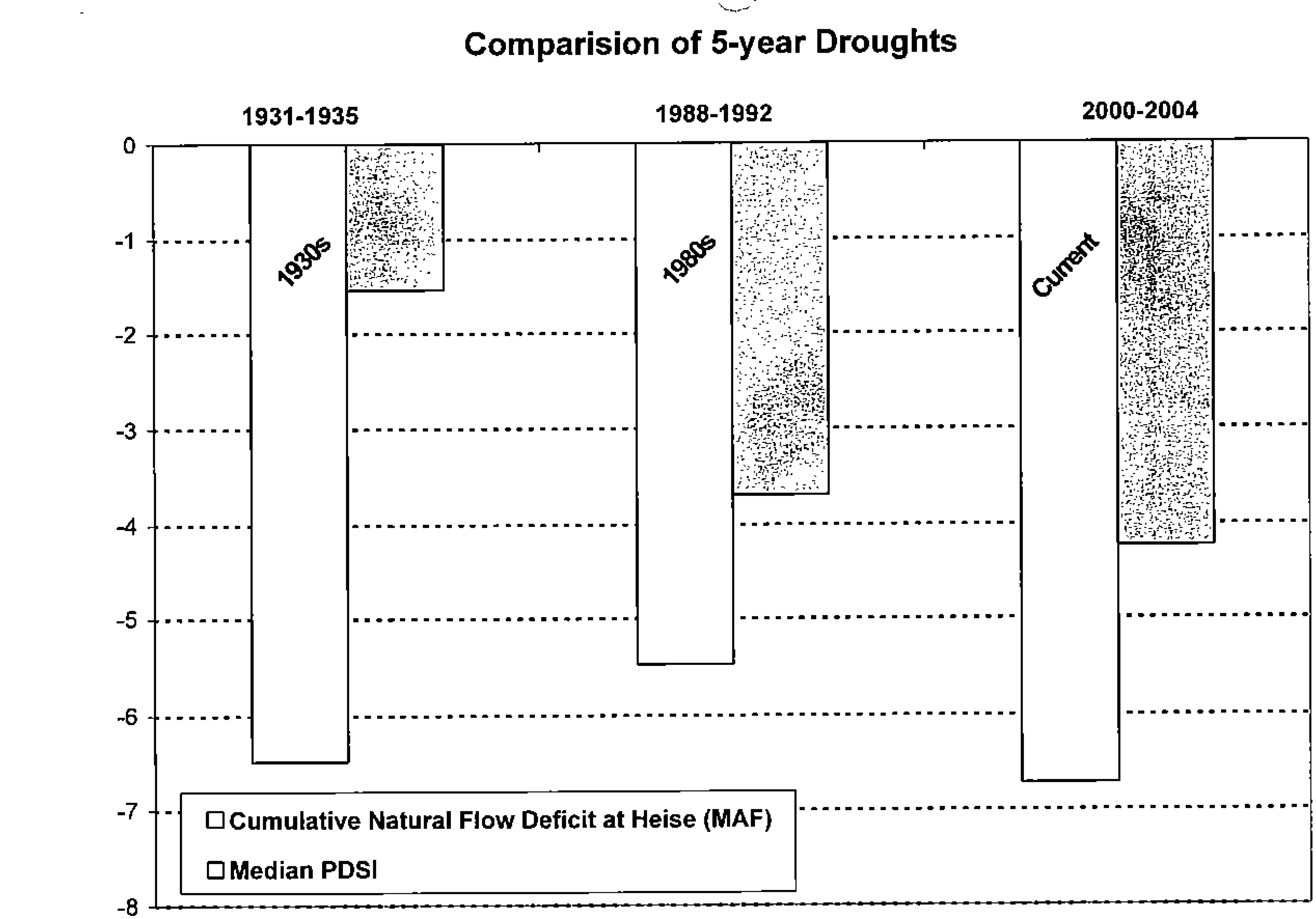
Source: IDWR: ftp://ftp.state.id.us/IDWR/Outgoing/

HYDROSPHERE Resource Consultants

December 2005

Figure 2-5

Annual Natural Flow at Heise



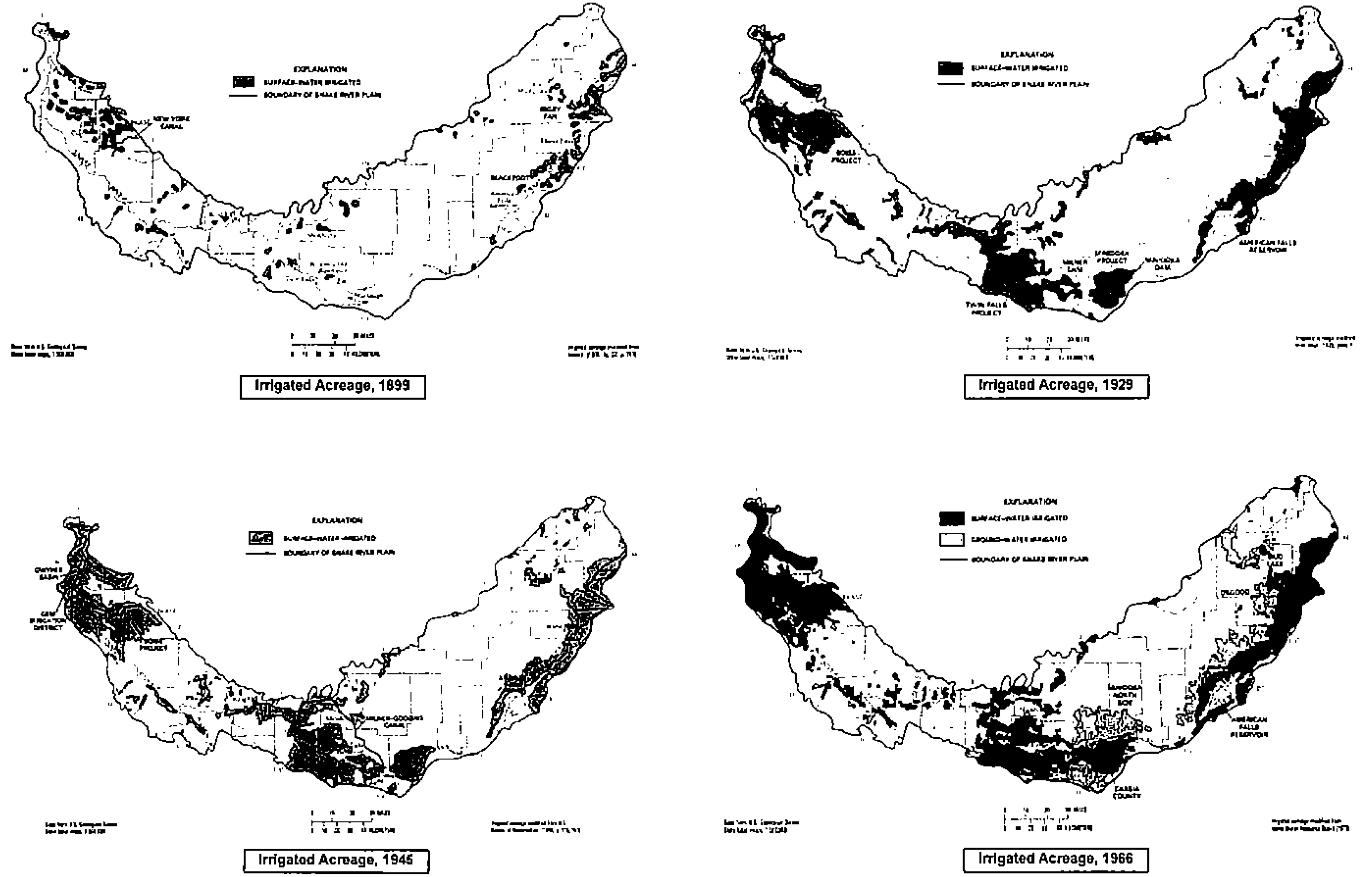
Source: PDIS data from http://www.cdc.noaa.gov/cgi-bin/Timeseries/timeseries1.pl
Heise NF from Ondrechen.xls @ ftp://ftp.state.id.us/IDWR/Outgoing/

HYDROSPHERE Resource Consultants

December, 2005

Figure 2-6

Comparison of Current and Historical 5-Year Droughts



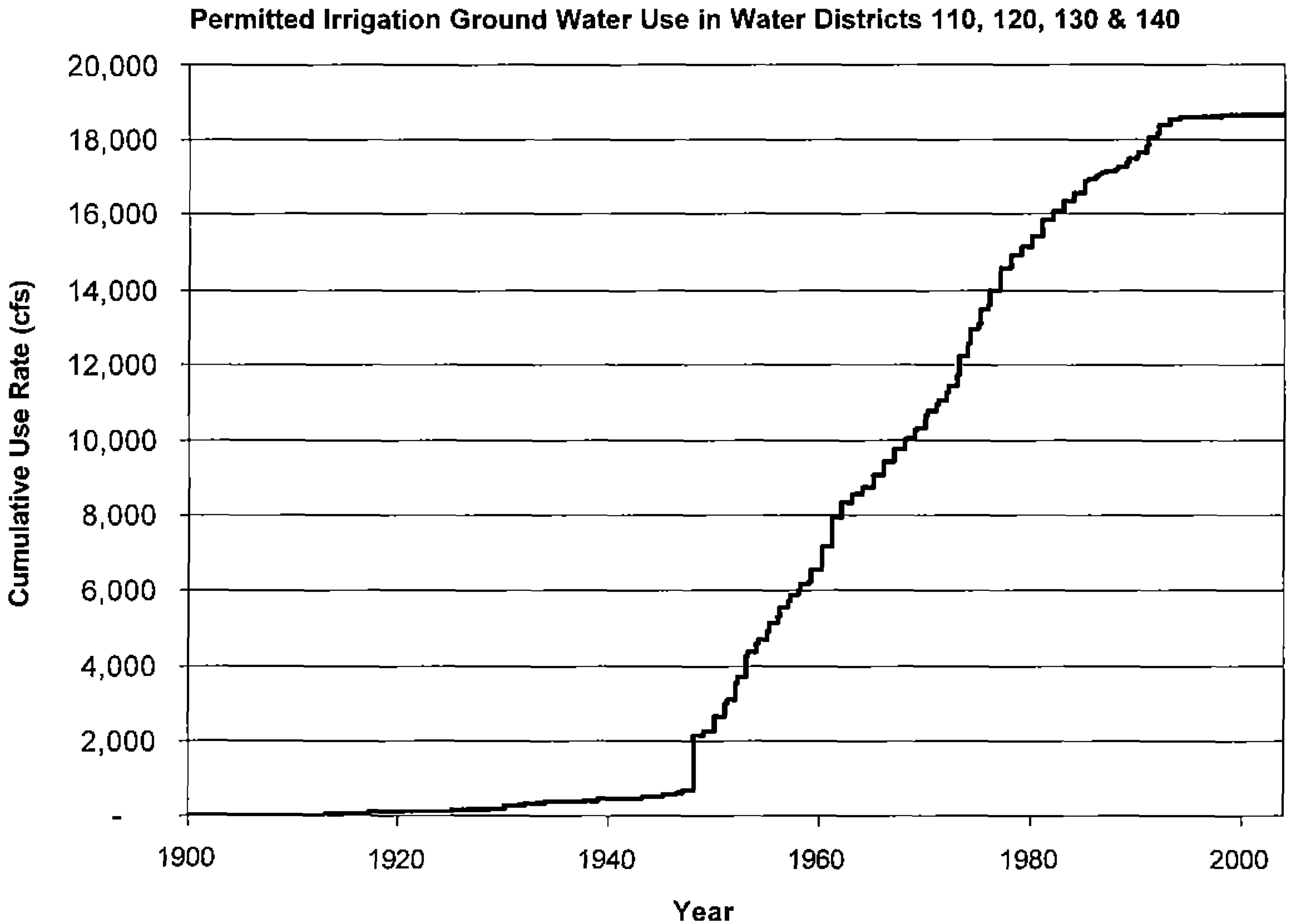
Source: Goodell, 1988

Figure 2-7

Evolution of Irrigation Development on the Snake River Plain

HYDROSPHERE Resource Consultants

December, 2005



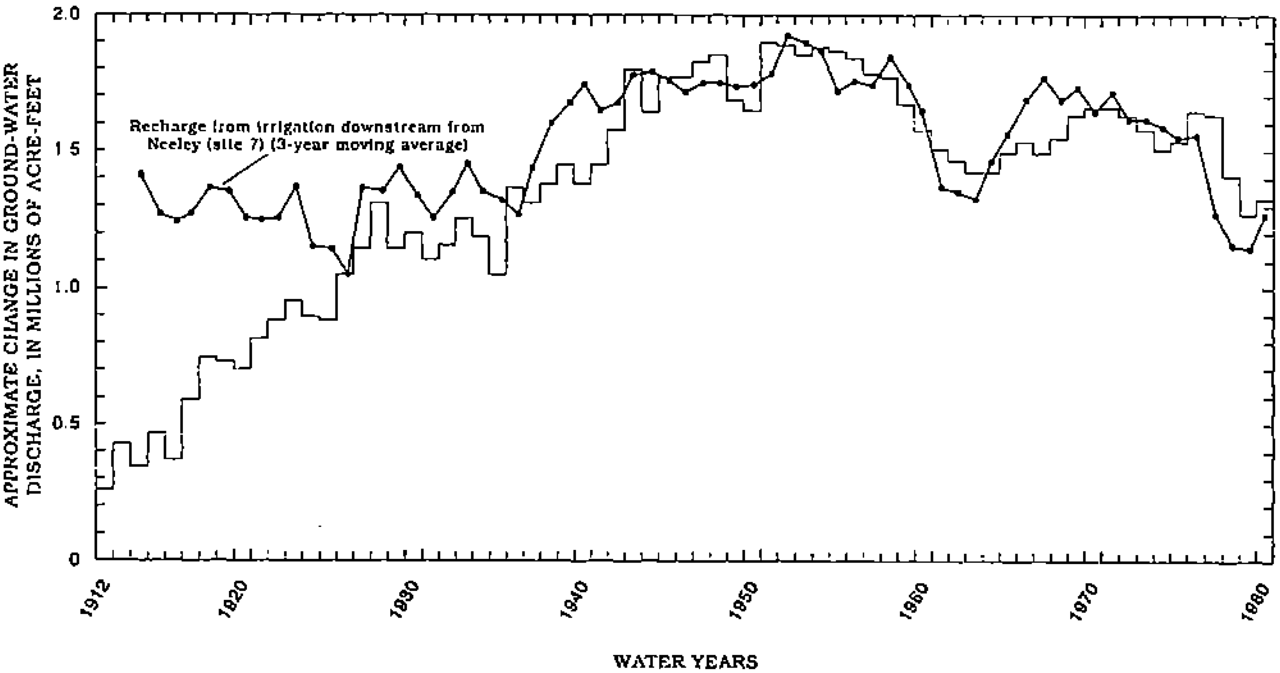
Source: Derived from ESRI Shapefiles for "Places of Use" data and water district boundaries, provided by IDWR

HYDROSPHERE Resource Consultants

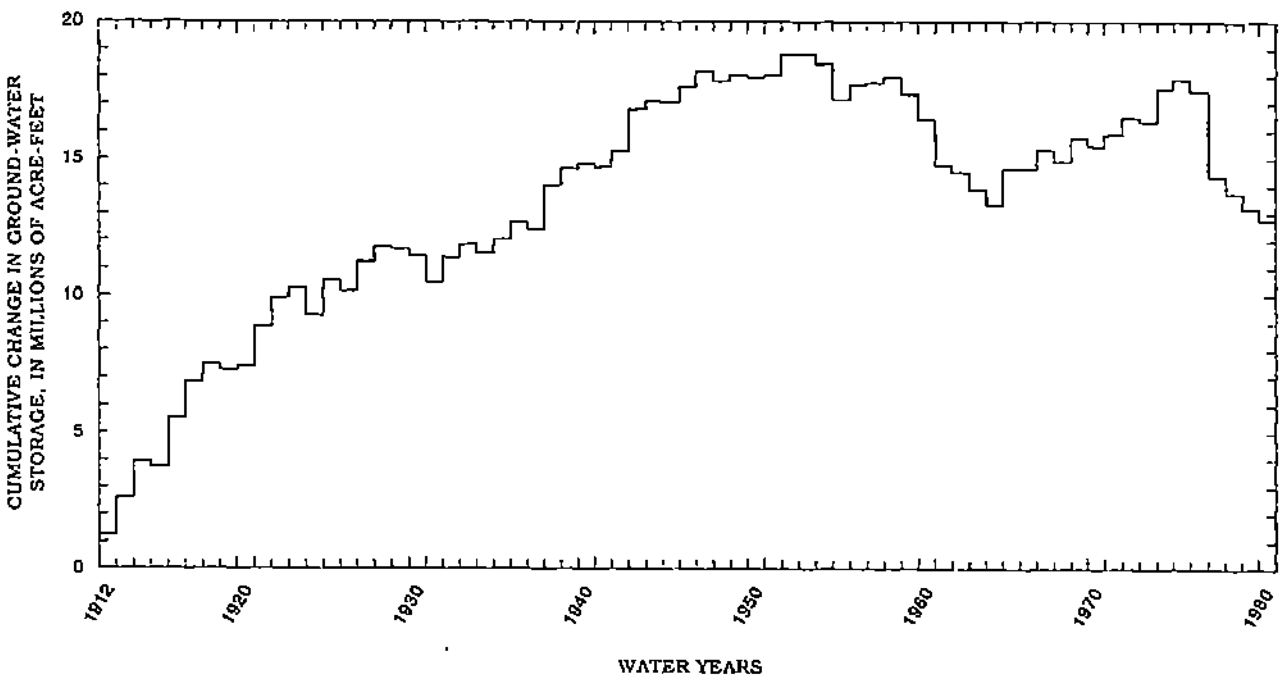
December, 2005

Figure 2-8

Evolution of Permitted Ground Water Use for Irrigation



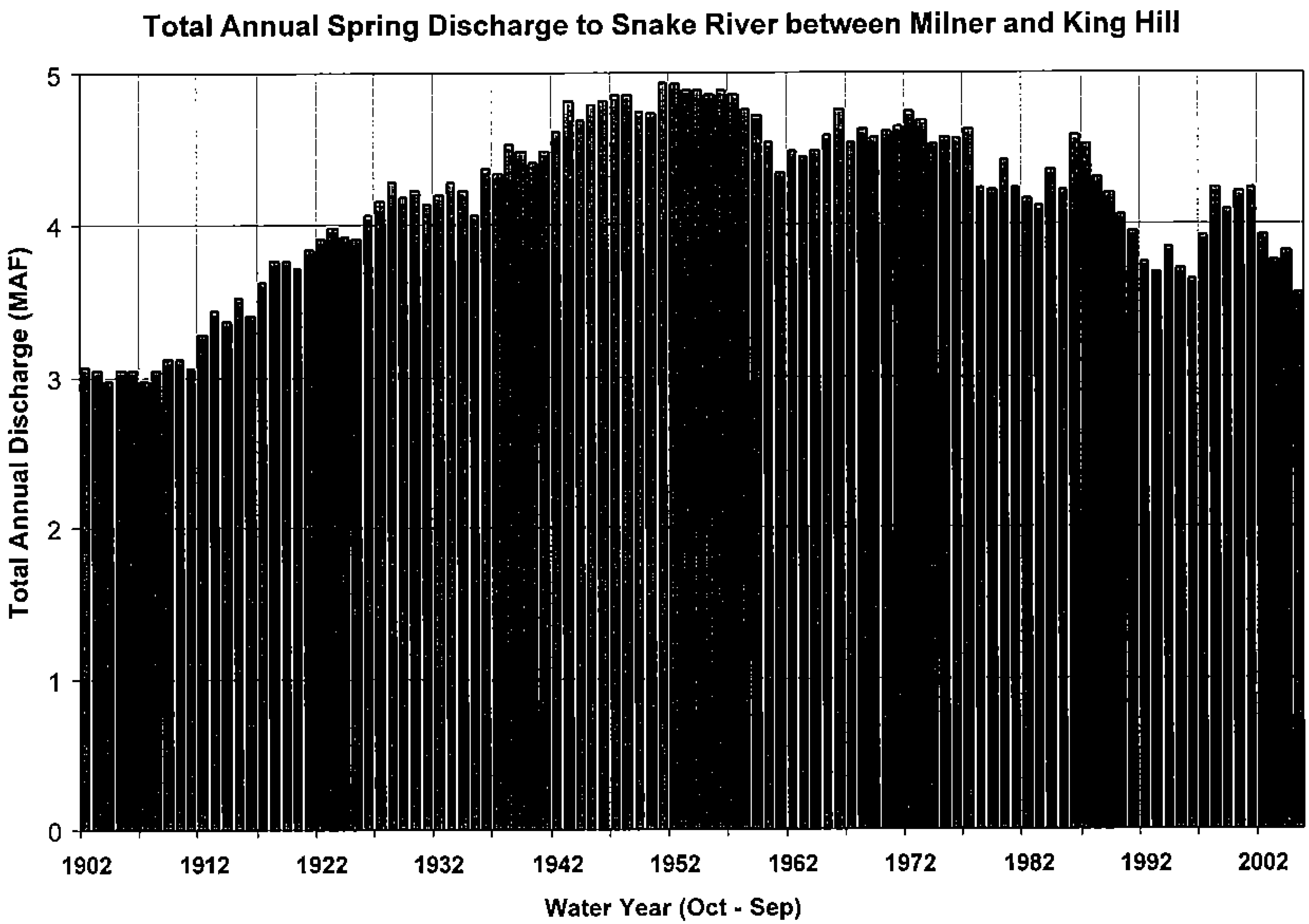
(a)—Approximate change in ground-water discharge to the north side of the Snake River, from estimates in 1911, between Milner (site 9) and King Hill (site 13), water years 1912–80



(b)—Cumulative annual changes in ground-water storage, main part of the eastern Snake River Plain, water years 1912–80

Source: Kjelstrom, 1995

HYDROSPHERE Resource Consultants December, 2005	Figure 2-9 **Changes in Ground Water Storage on Spring Discharge, 1912 - 1980**



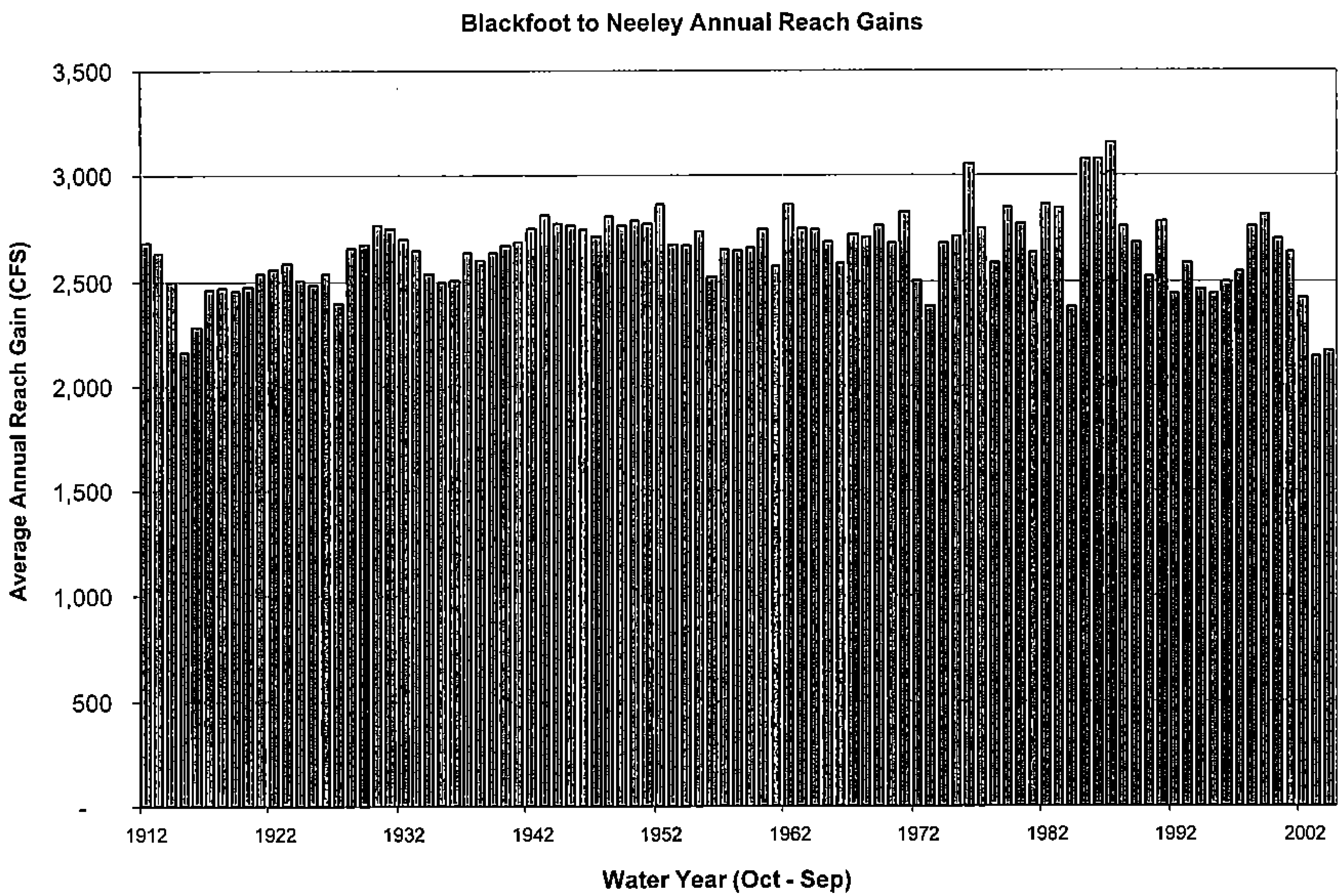
Source: IDWR, 2005

HYDROSPHERE Resource Consultants

December, 2005

Figure 2-10

Total Annual Spring Discharge in the Thousand Springs Reach, 1902 - 2005



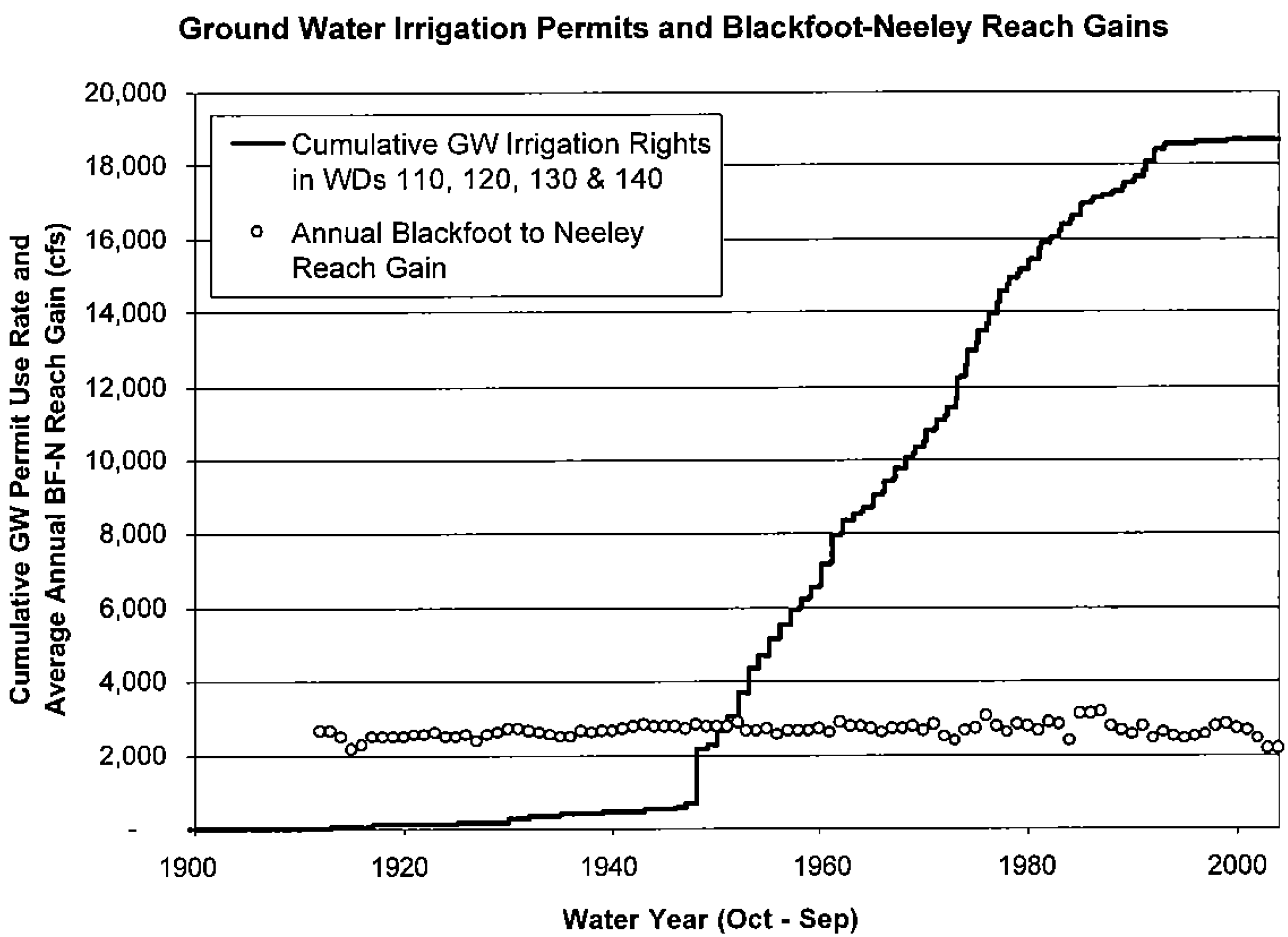
Source: USGS, 1938
IDWR, 2005: "blackfoot_neeley_gains.xls"
ftp://ftp.state.id.us/IDWR/Outgoing/SWCoalition/

HYDROSPHERE Resource Consultants

December, 2005

Figure 2-11

Annual Blackfoot to Neeley Reach Gains, 1912 - 2004



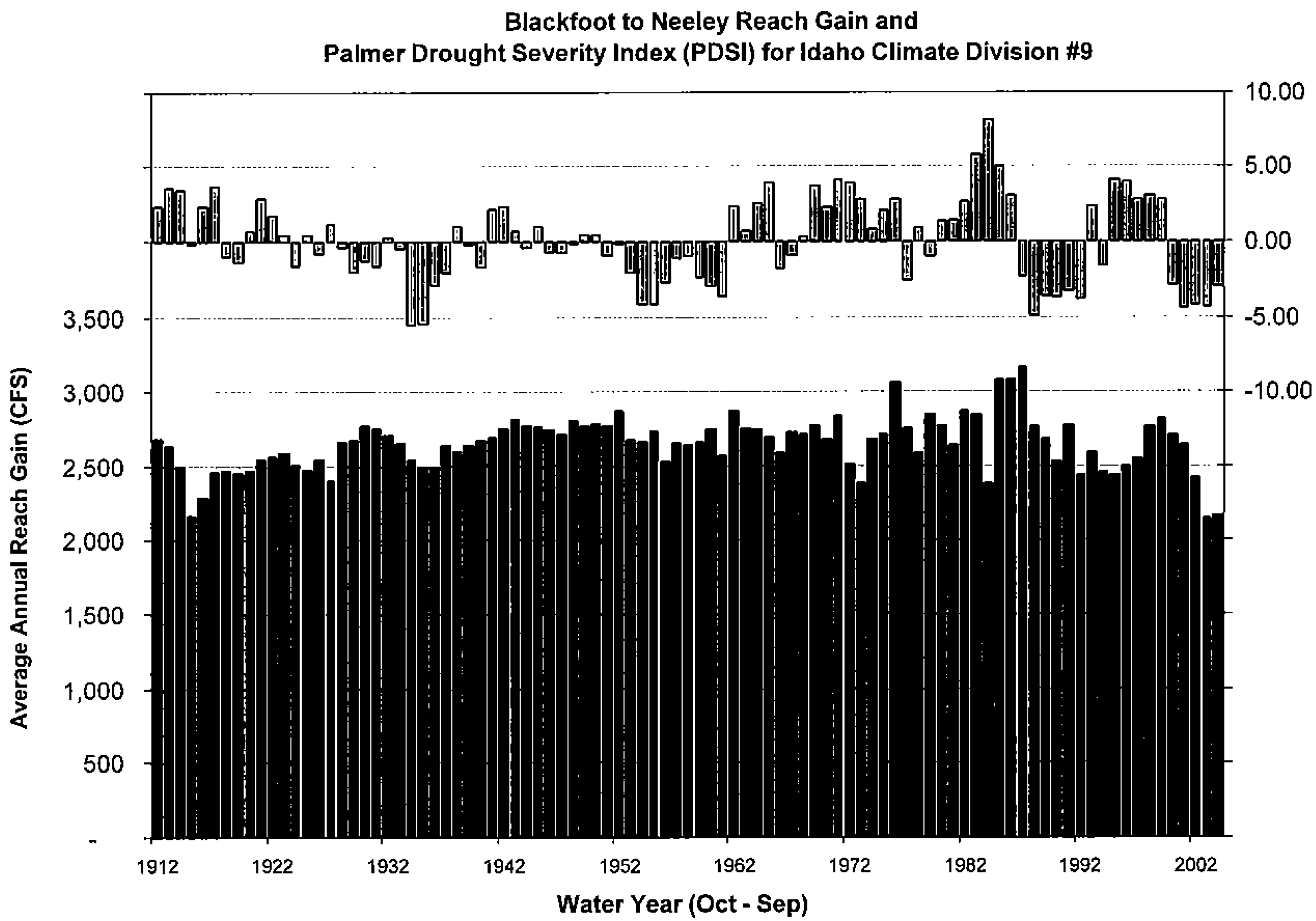
Source: Cumulative Permits derived from ESRI Shapefiles for "Places of Use" data and water district boundaries, provided by IDWR
Gains from USGS, 1938 and IDWR, 2005: "blackfoot_neeley_gains.xls" ftp://ftp.state.id.us/IDWR/Outgoing/SWCoalition/

HYDROSPHERE Resource Consultants

December, 2005

Figure 2-12

Reach Gains and Ground Water Irrigation Permits



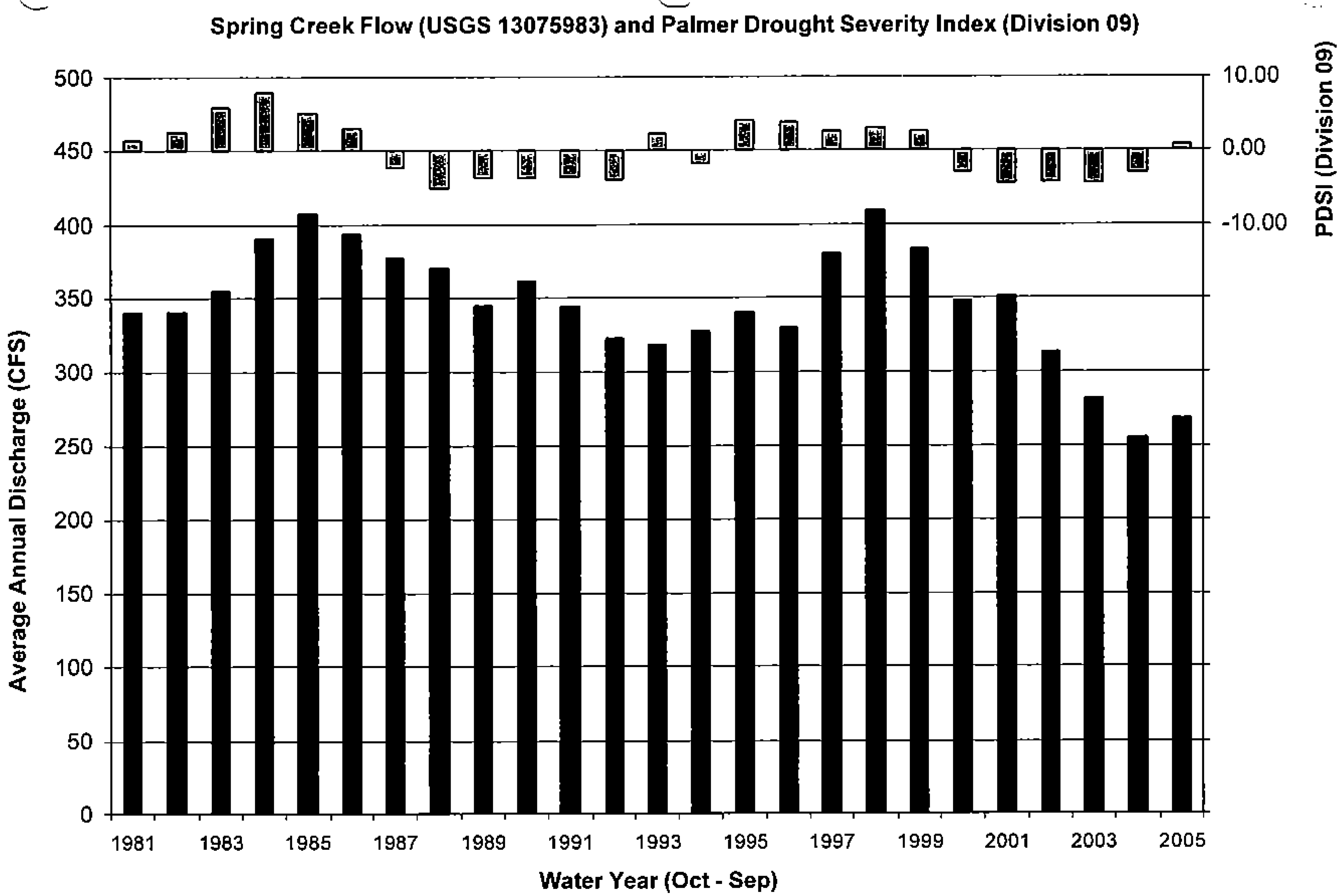
Source: NOAA: http://www.cdc.noaa.gov/cgi-bin/Timeseries/timeseries1.pl
IDWR: ftp://ftp.state.id.us/IDWR/Outgoing/

HYDROSPHERE Resource Consultants

December 2005

Figure 2-13

Blackfoot to Neeley Annual Reach Gains and Palmer Drought Severity Index for Climate Division 9



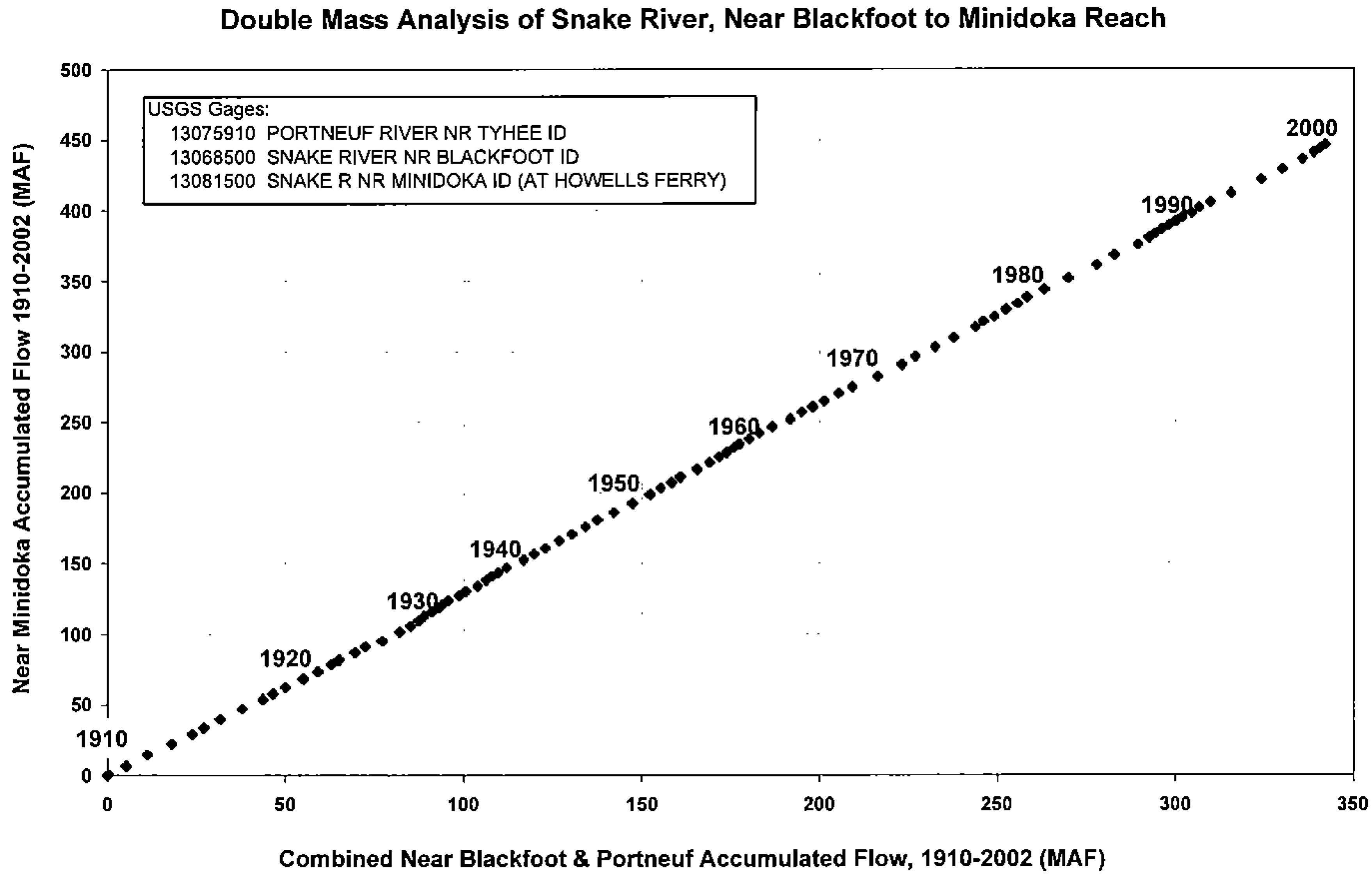
Source: NOAA: http://www.cdc.noaa.gov/cgi-bin/Timeseries/timeseries1.pl
USGS: http://nwis.waterdata.usgs.gov/nwis/discharge/?site_no=13075983&agency_cd=USGS

HYDROSPHERE Resource Consultants

December, 2005

Figure 2-14

Spring Creek Flow and Palmer Drought Severity Index for Division 9



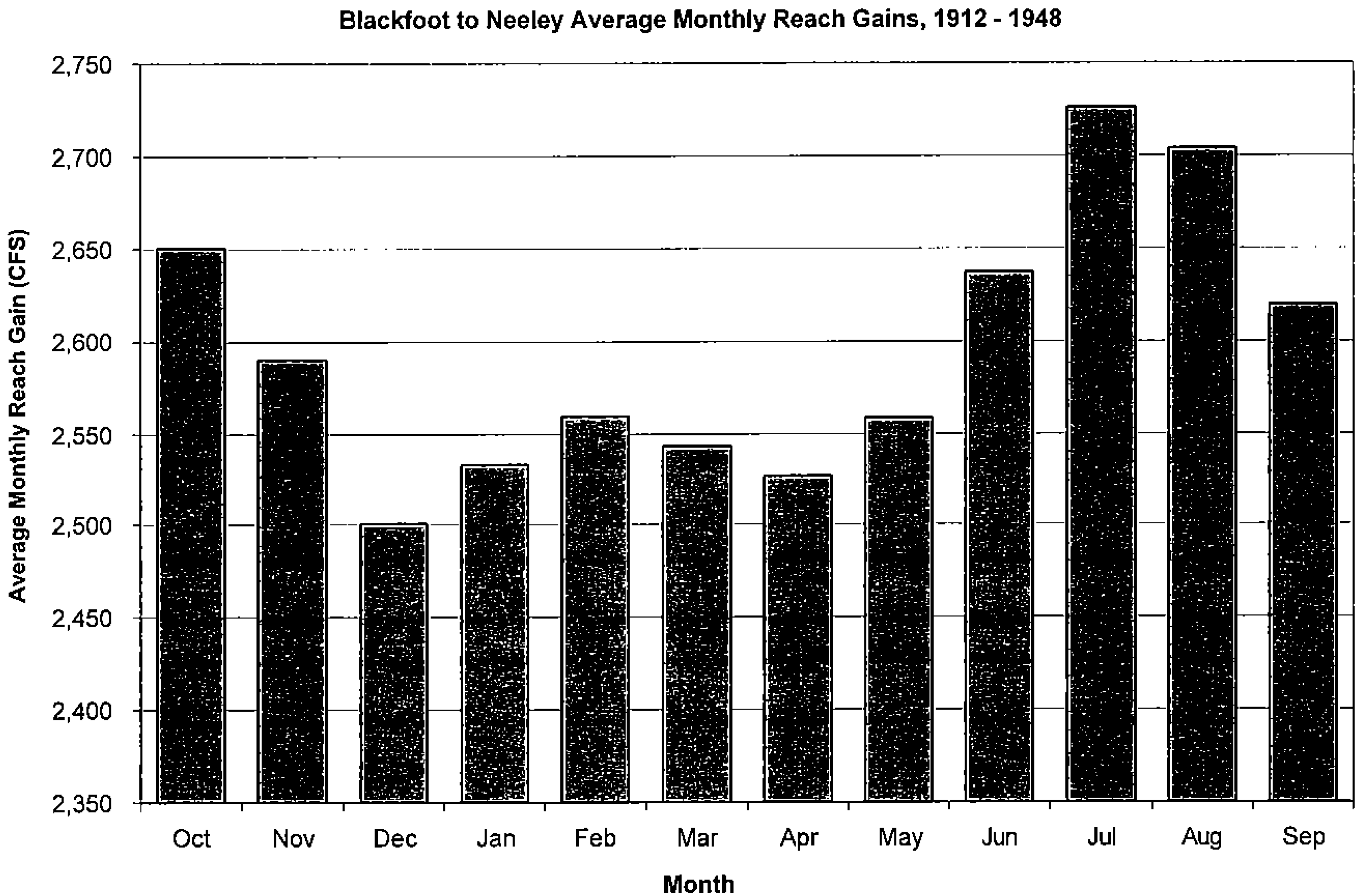
Source: USGS: http://nwis.waterdata.usgs.gov/nwis/discharge

HYDROSPHERE Resource Consultants

December 2005

Figure 2-15

Double Mass Analysis, Near Blackfoot to Minidoka Reach



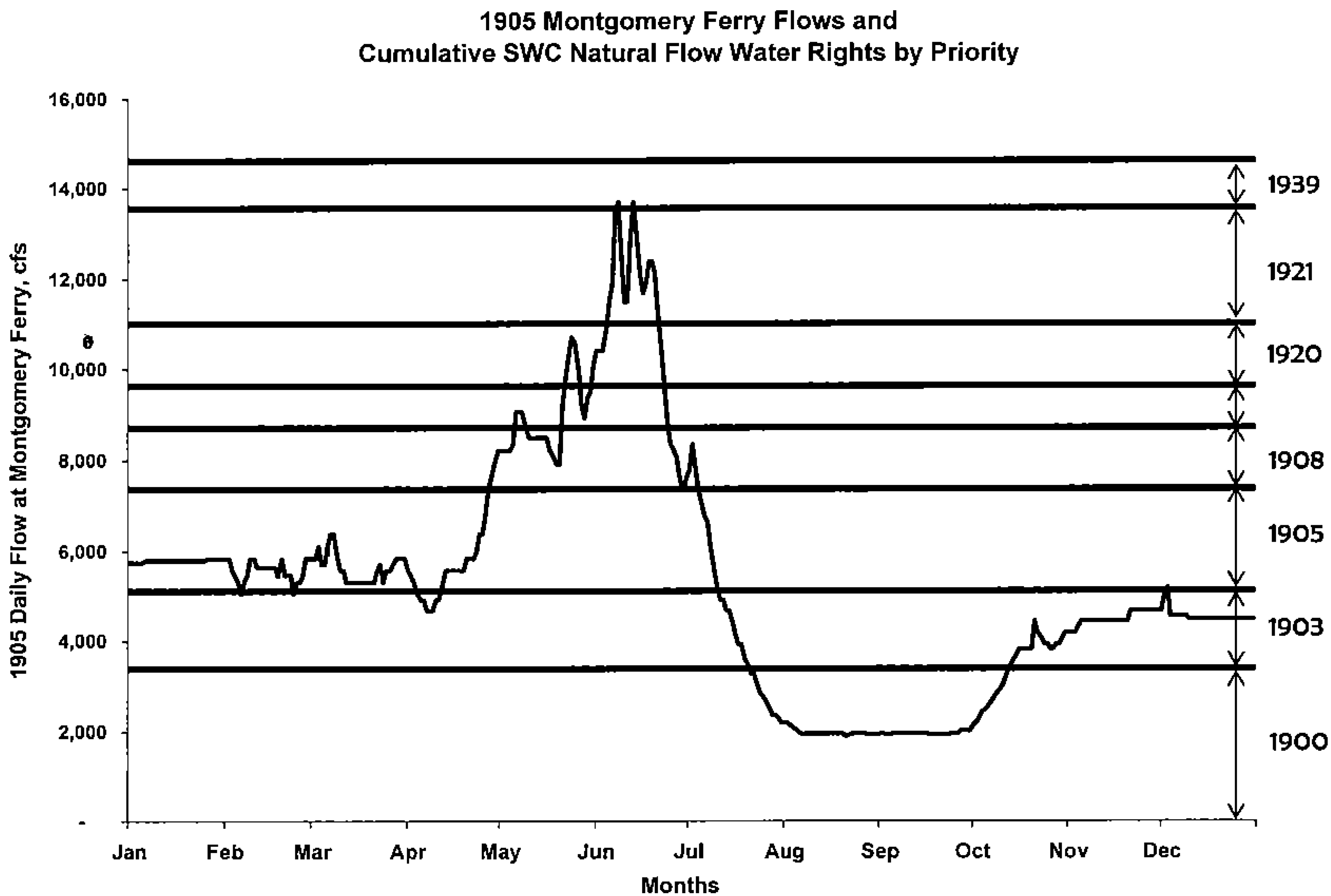
Source: USGS, 1938
IDWR, 2005: "blackfoot_neeley_gains.xls"
ftp://ftp.state.id.us/IDWR/Outgoing/SWCoalition/

HYDROSPHERE Resource Consultants

December, 2005

Figure 3-1

Monthly Average Reach Gains, Blackfoot to Neeley, 1912 - 1948



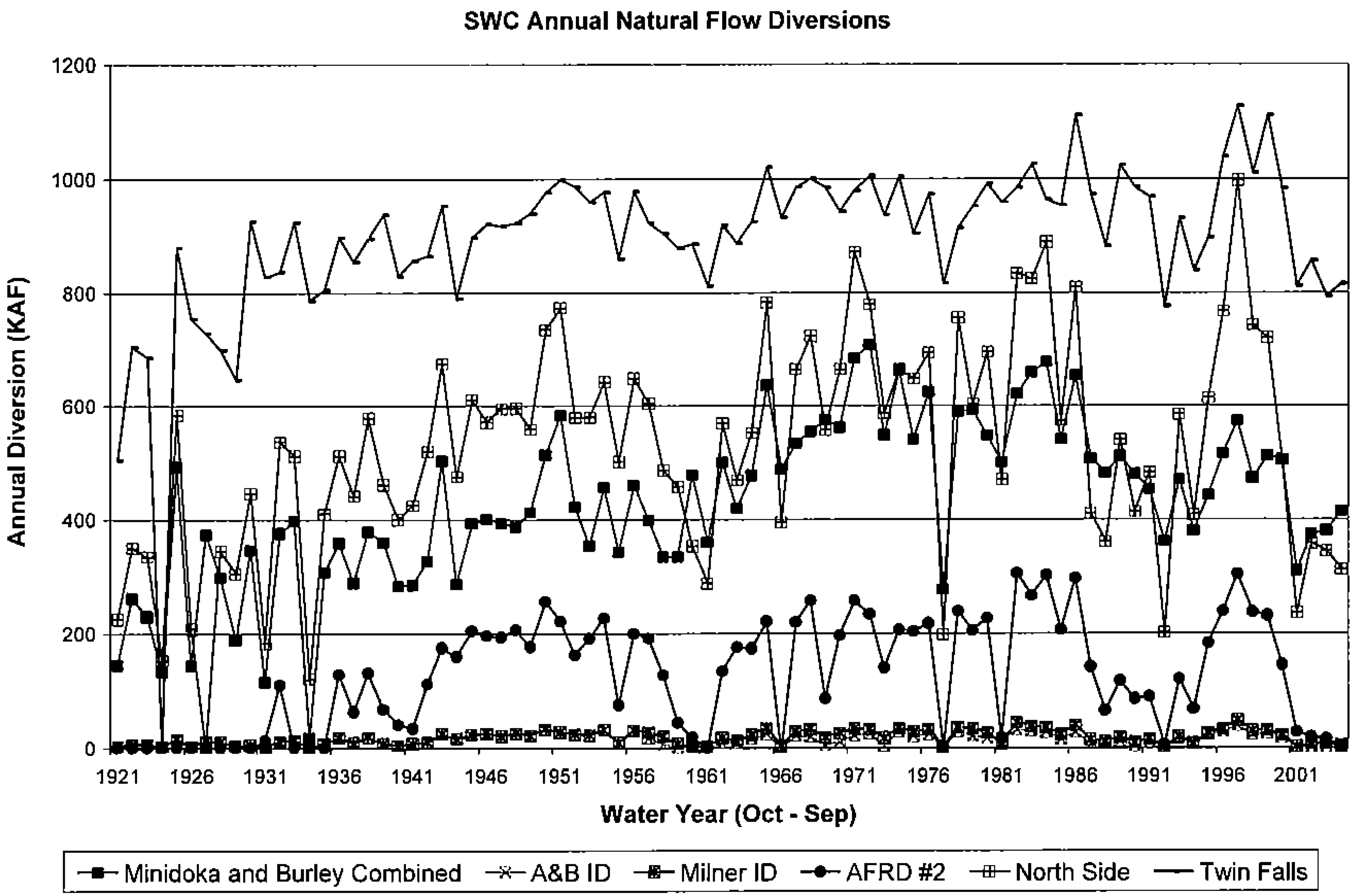
Source: USGS, 1950, Water District 01 Data

HYDROSPHERE Resource Consultants

December 2005

Figure 3-2

Daily Flow at Montgomery Ferry in 1905 and NF Priorities of the SWC



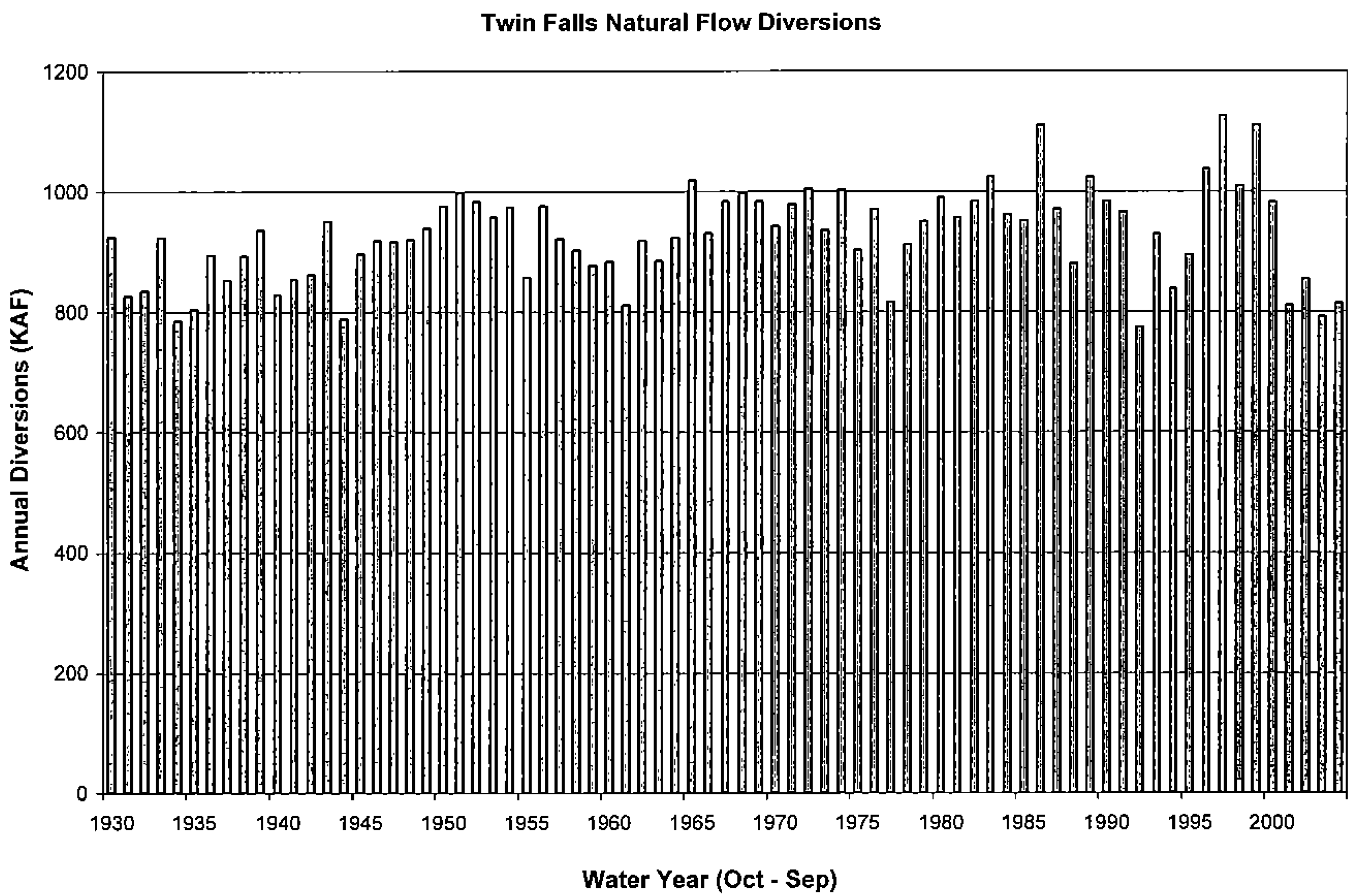
Source: Water District 36 and 01 Accounting Reports

HYDROSPHERE Resource Consultants

December, 2005

Figure 3-3

Annual Natural Flow Diversions of SWC Entities



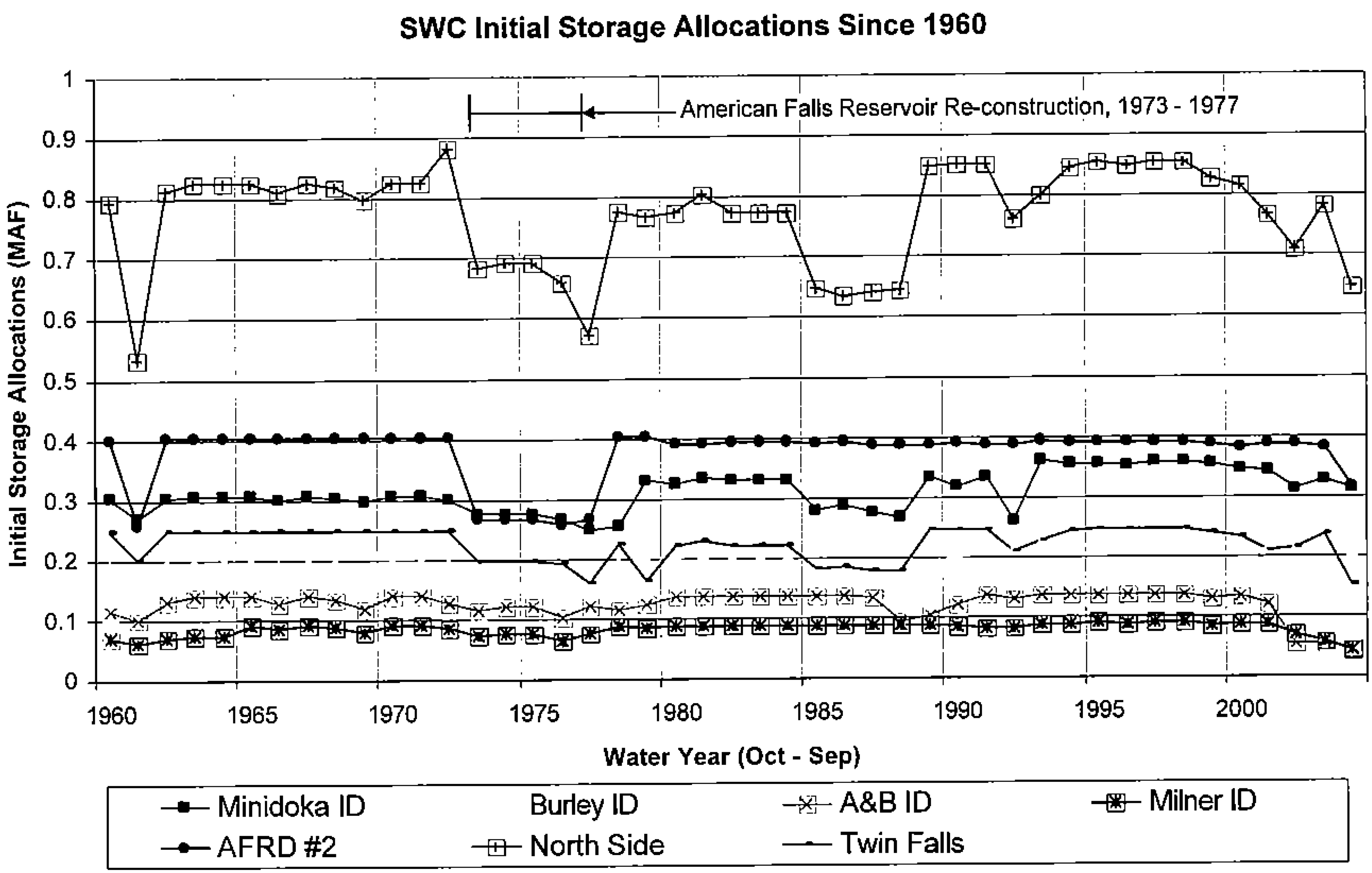
Source: Water District 36 and 01 Accounting Reports

HYDROSPHERE Resource Consultants

December, 2005

Figure 3-4

Annual Twin Falls Natural Flow Diversions Since 1930



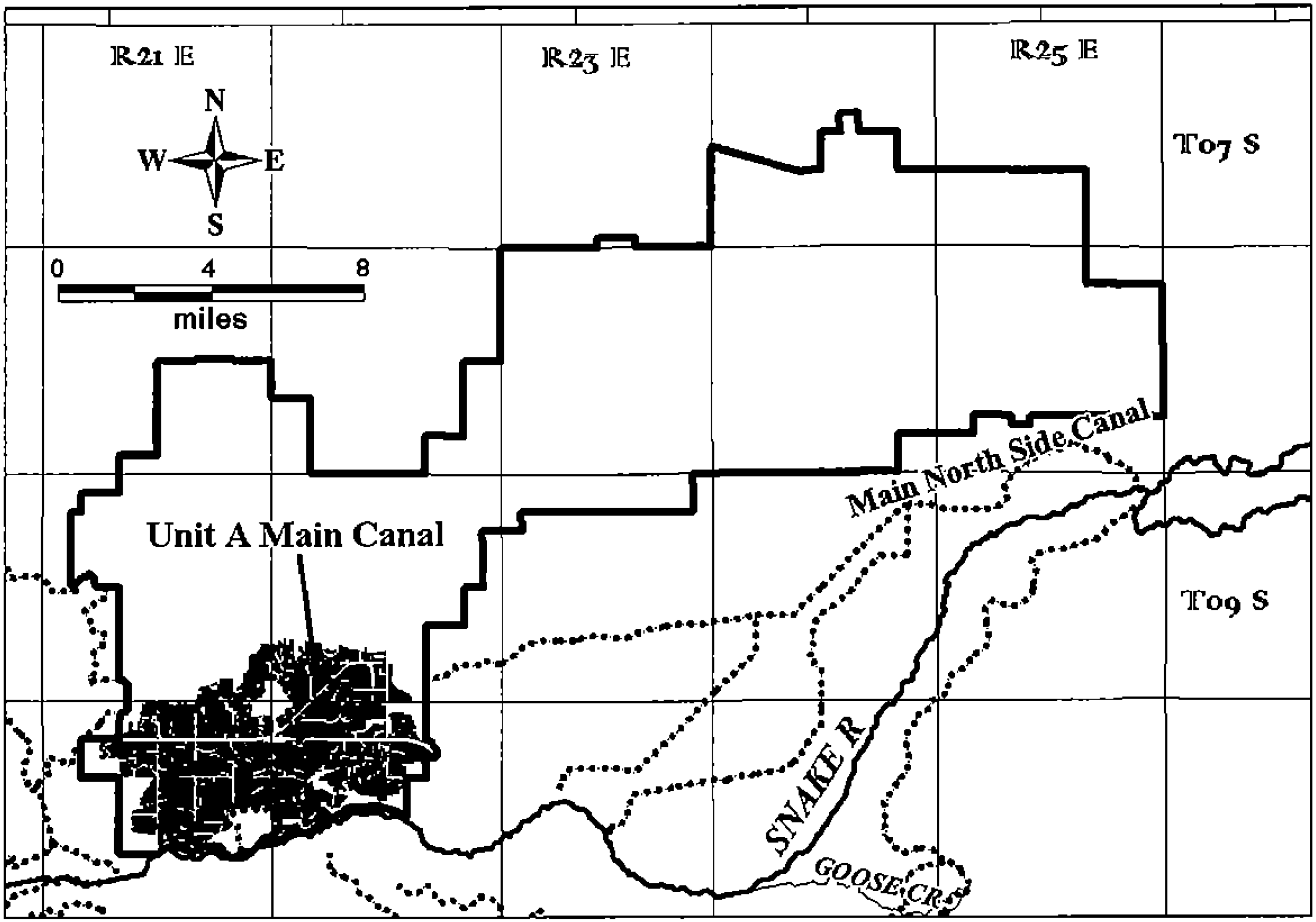
Source: Water District 36 and 01 Accounting Reports

HYDROSPHERE Resource Consultants

December, 2005

Figure 3-5

Initial Storage Allocations since 1960



Total acres claimed and permitted: 16,467 acres

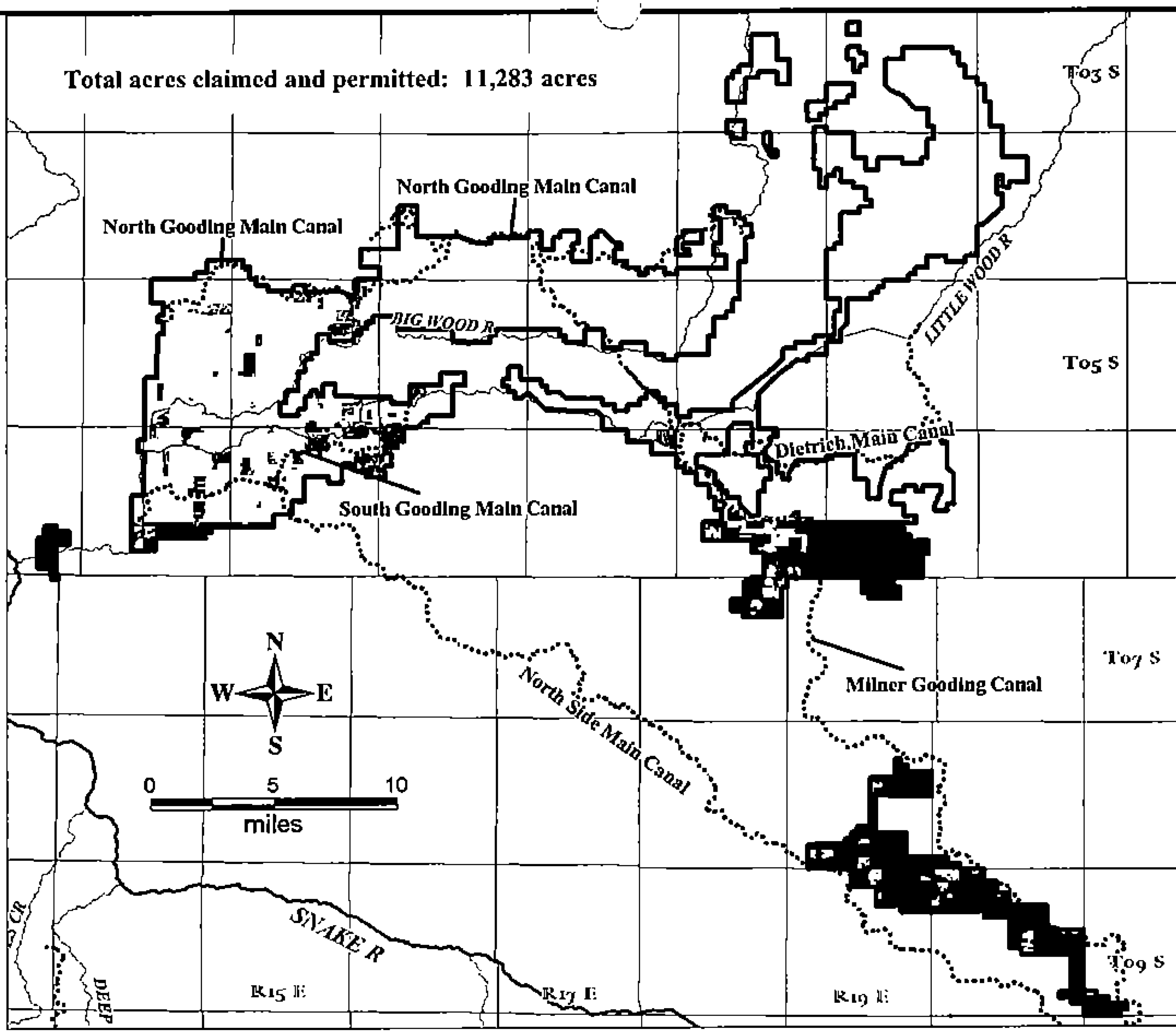
Source: Base map layers (townships, rivers, canals) from Idaho Inside: http://inside.uidaho.edu/
POUs, SRBA Claims, and Canal Company Boundaries provided by IDWR

HYDROSPHERE Resource Consultants

December, 2005

Figure 3-6

A&B Irrigation District Unit A Claimed Irrigated Lands Within Permitted Groundwater Places of Use



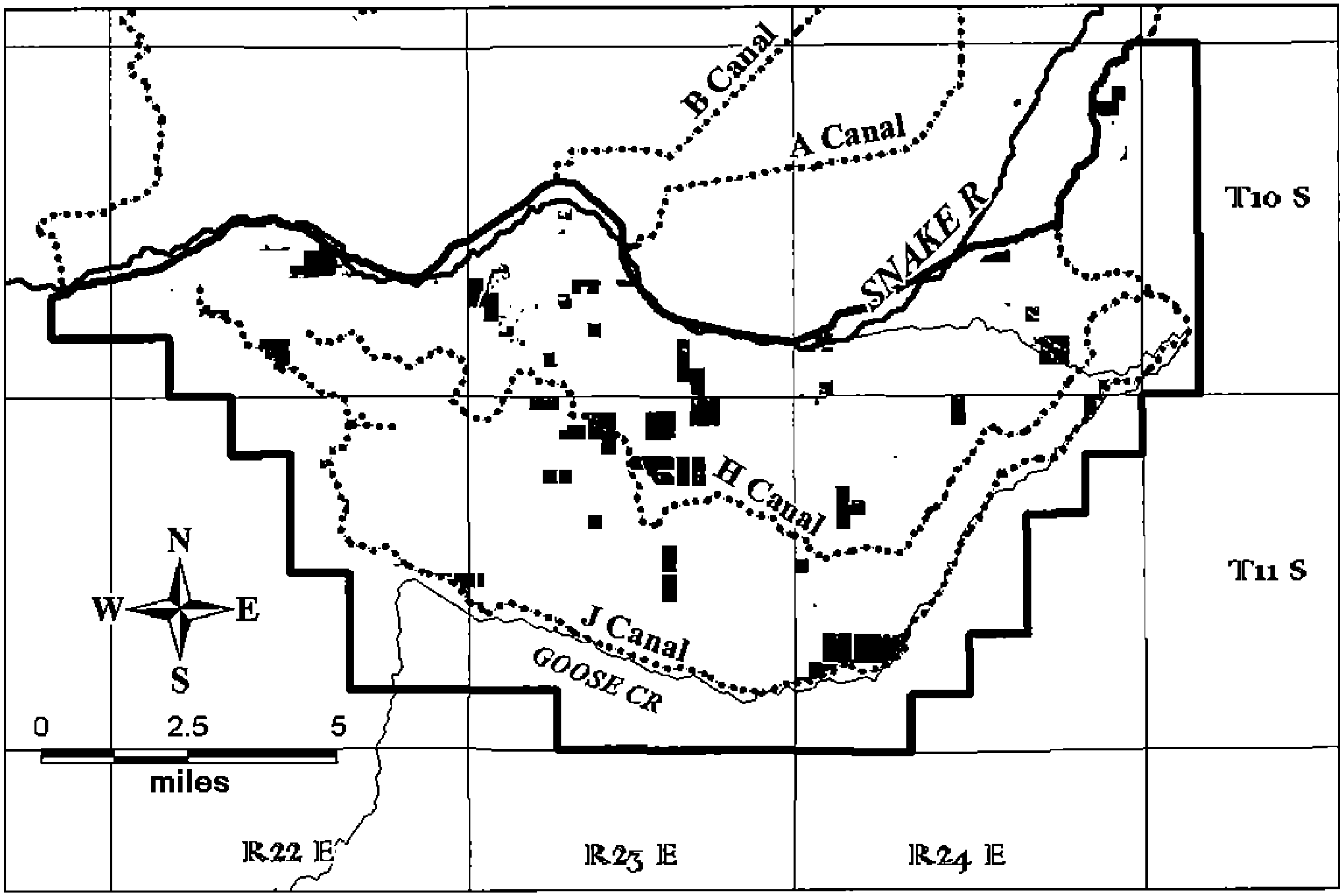
Source: Base map layers (townships, rivers, canals) from Idaho Inside: http://inside.uidaho.edu/
POUs, SRBA Claims, and Canal Company Boundaries provided by IDWR

HYDROSPHERE
Resource Consultants

December, 2005

Figure 3-7

American Falls Irrigation District Claimed Irrigated Lands Within Permitted GW Places of Use



Total acres claimed and permitted: 3,738 acres

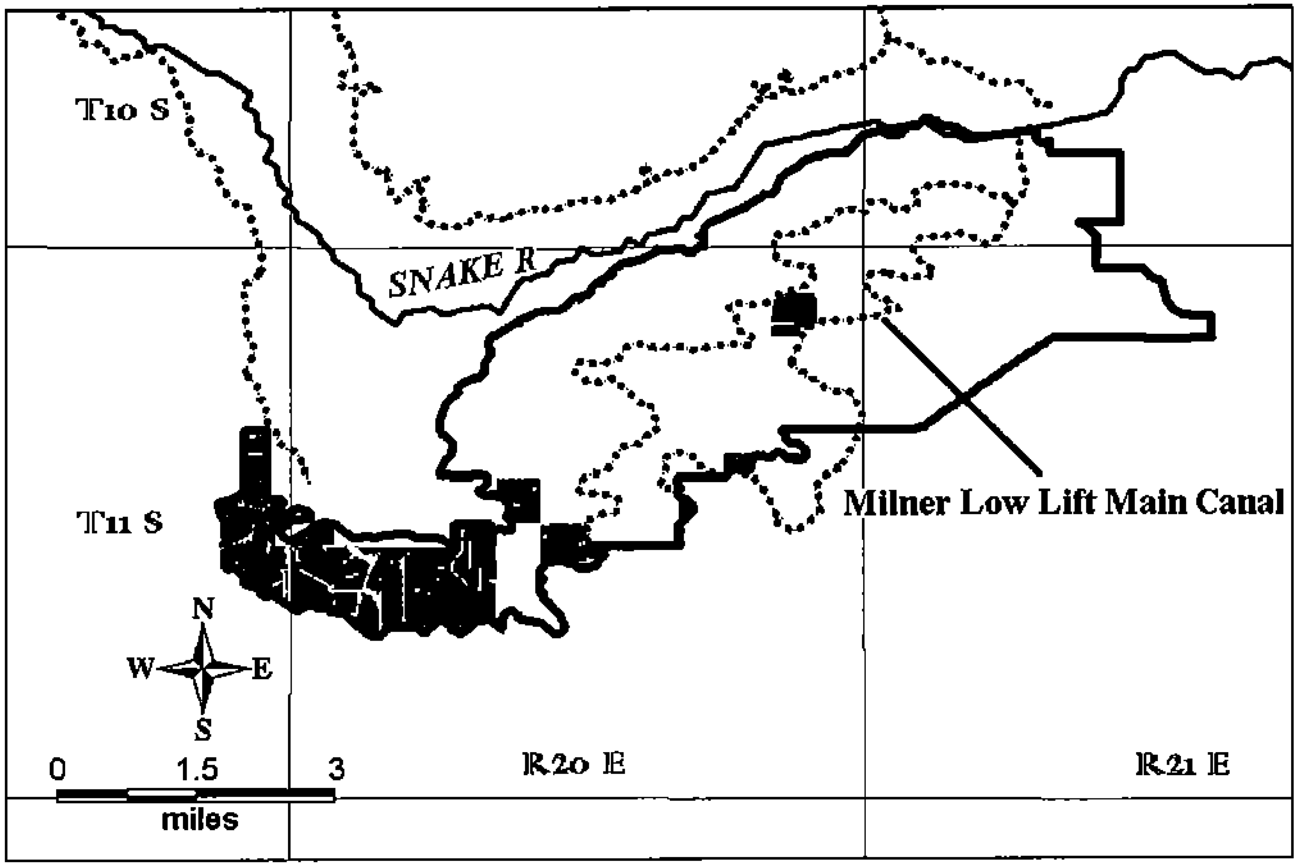
Source: Base map layers (townships, rivers, canals) from Idaho Inside: http://inside.uidaho.edu/
POUs, SRBA Claims, and Canal Company Boundaries provided by IDWR

HYDROSPHERE Resource Consultants

December, 2005

Figure 3-8

Burley Irrigation District Claimed Irrigated Lands Within Permitted Groundwater Places of Use



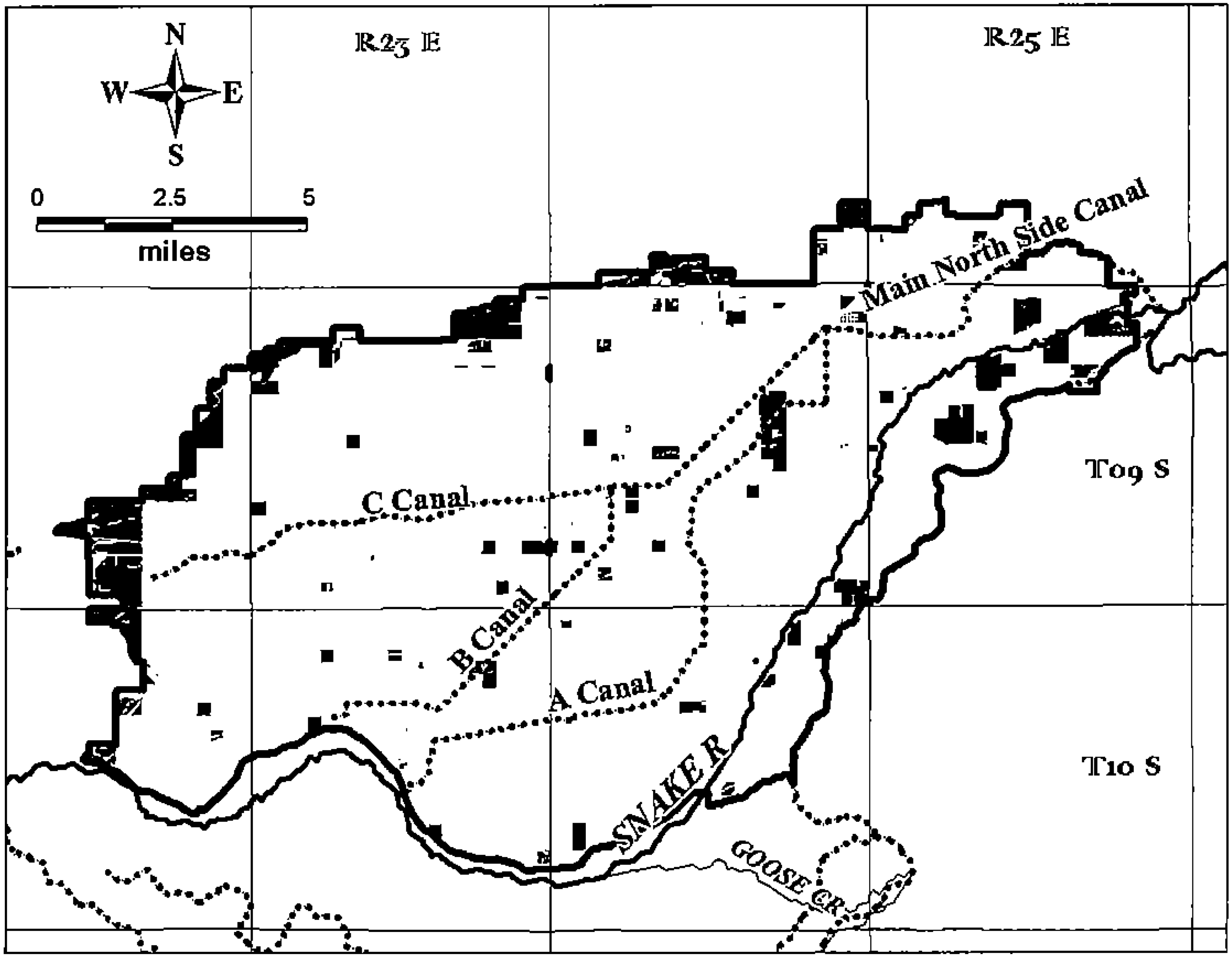
Total acres claimed and permitted: 2,112 acres

Source: Base map layers (townships, rivers, canals) from Idaho Inside: http://inside.uidaho.edu/
POUs, SRBA Claims, and Canal Company Boundaries provided by IDWR

HYDROSPHERE Resource Consultants
December, 2005

Figure 3-9

Milner Irrigation District Claimed Irrigated Lands Within Permitted Groundwater Places of Use



Total acres claimed and permitted: 7,300 acres

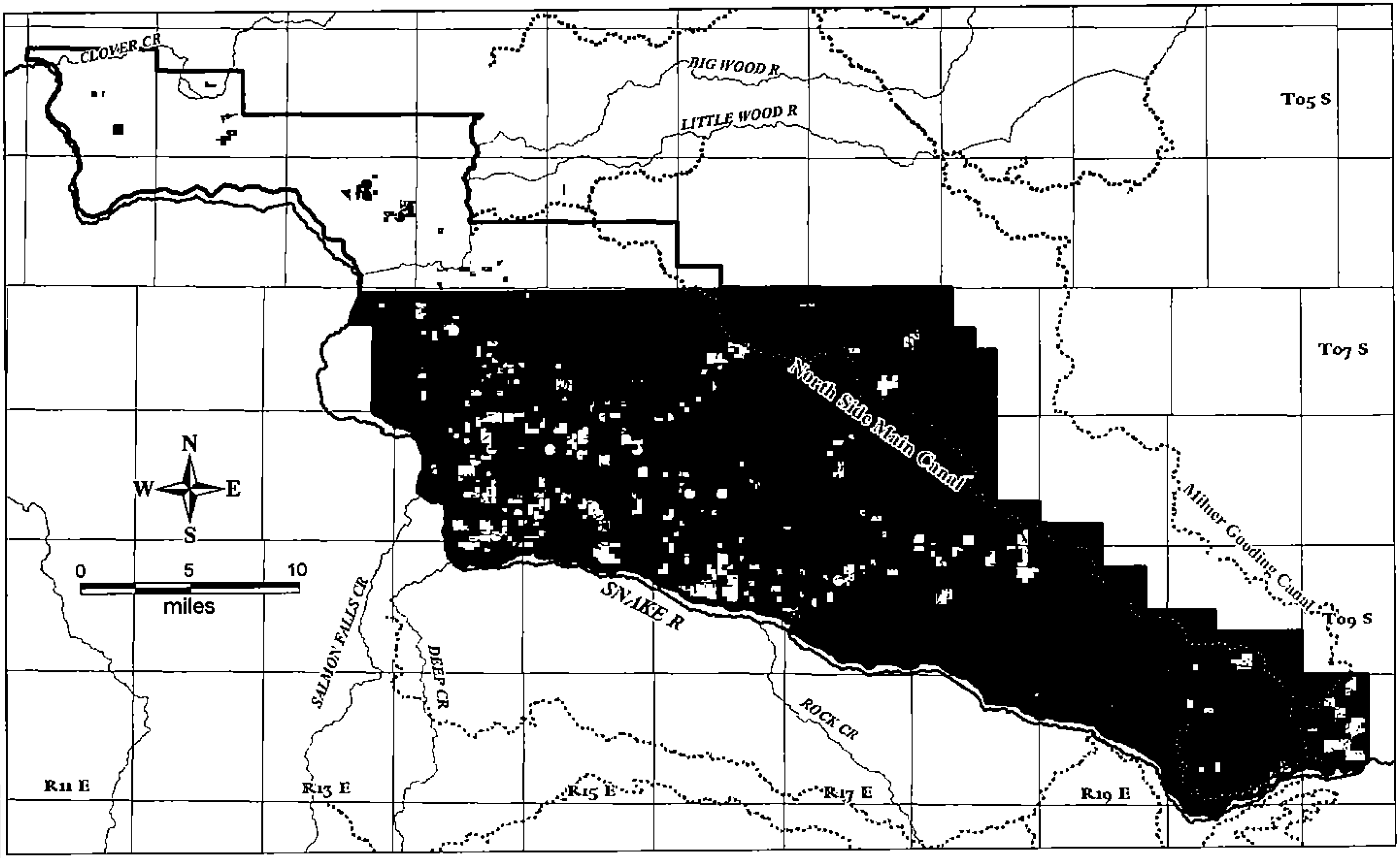
Source: Base map layers (townships, rivers, canals) from Idaho Inside: http://inside.uidaho.edu/
POUs, SRBA Claims, and Canal Company Boundaries provided by IDWR

HYDROSPHERE Resource Consultants

December, 2005

Figure 3-10

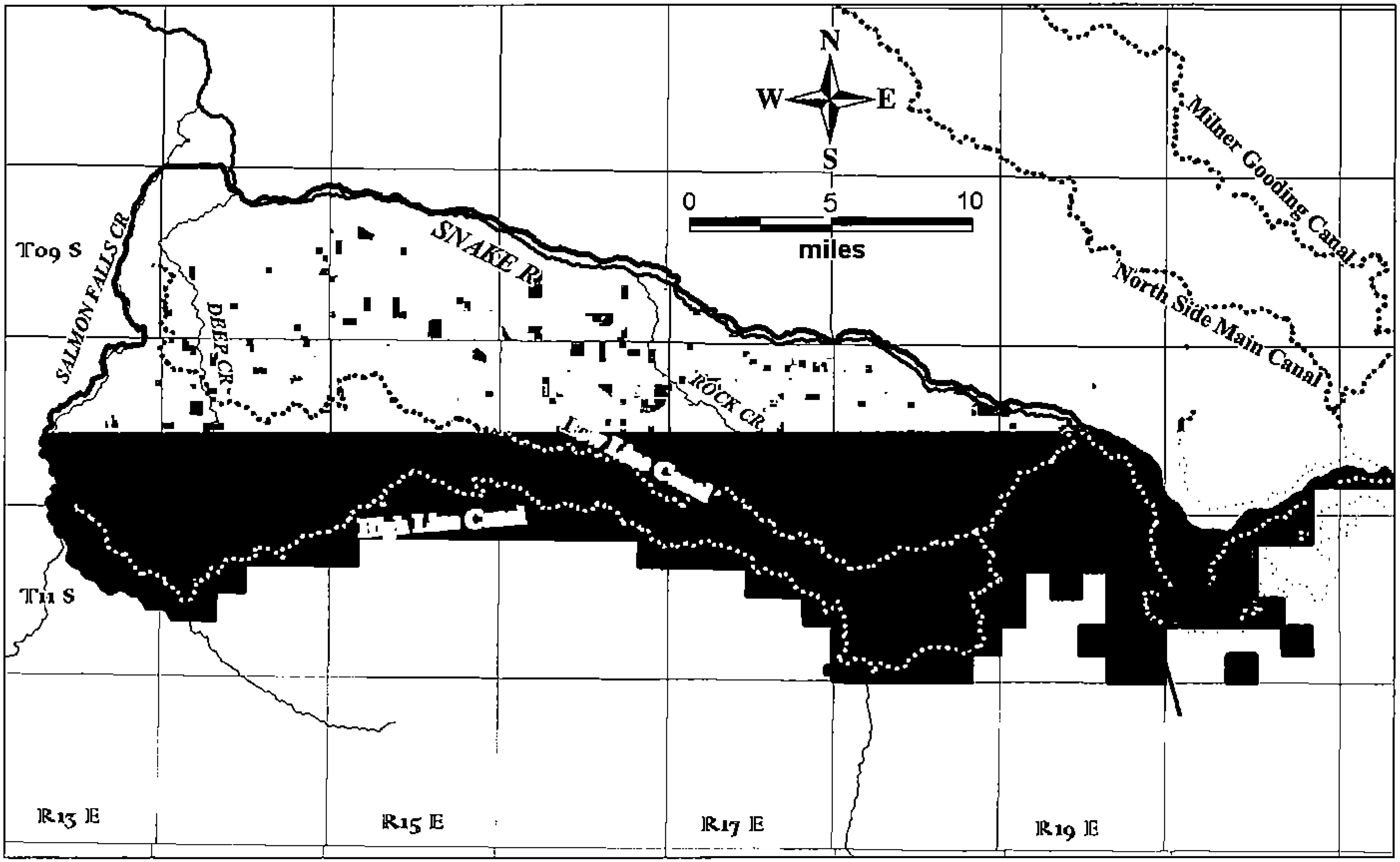
Minidoka Irrigation District Claimed Irrigated Lands Within Permitted Groundwater Places of Use



Total acres claimed and permitted: 21,117 acres

Source: Base map layers (townships, rivers, canals) from Idaho Inside: http://inside.uidaho.edu/ POUs, SRBA Claims, and Canal Company Boundaries provided by IDWR

HYDROSPHERE Resource Consultants December, 2005	Figure 3-11 **North Side Canal Company Claimed Irrigated Lands Within Permitted Groundwater Places of Use**



Total acres claimed and permitted: 12,838 acres

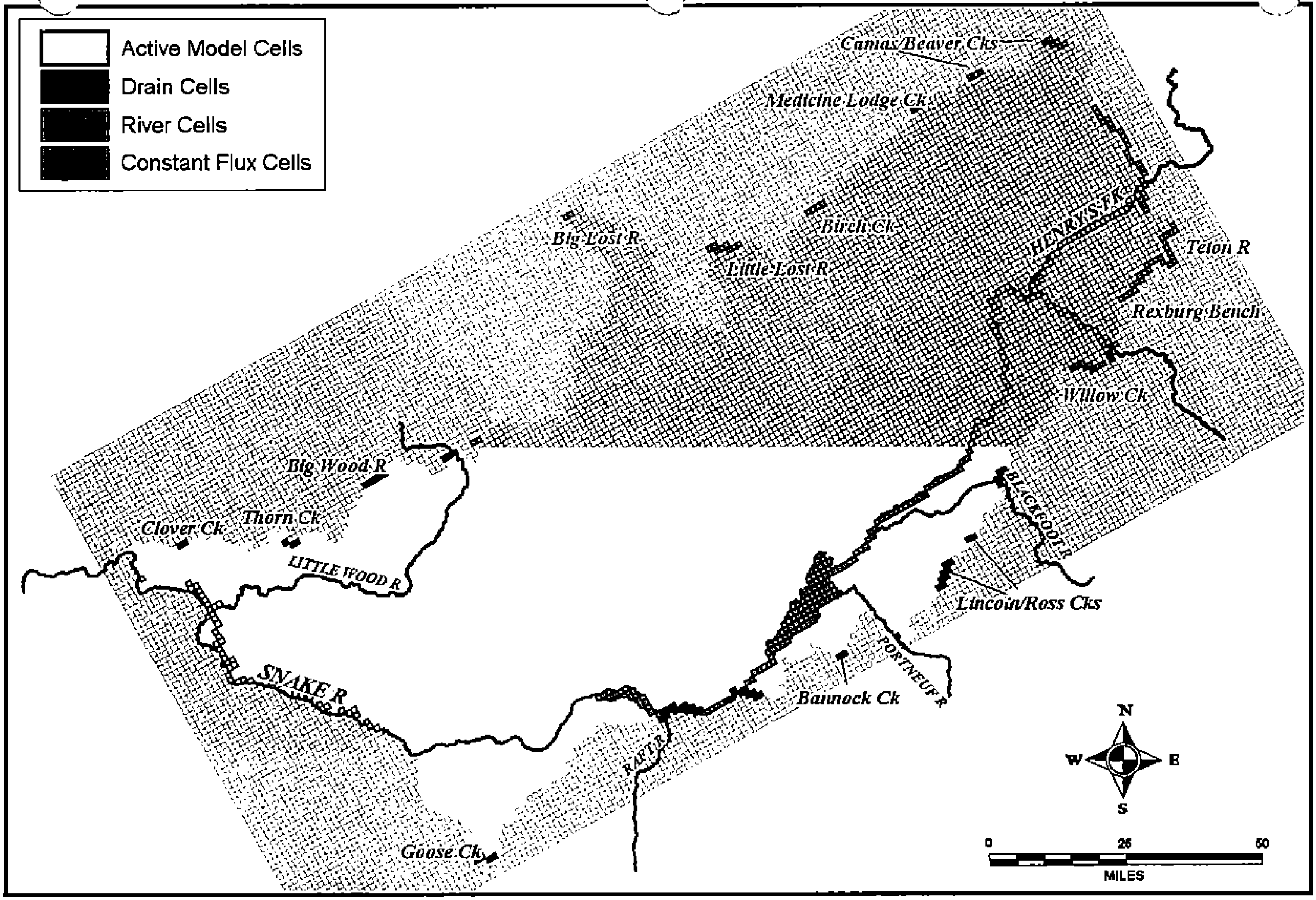
Source: Base map layers (townships, rivers, canals) from Idaho Inside: http://inside.uidaho.edu/ POUs, SRBA Claims, and Canal Company Boundaries provided by IDWR

HYDROSPHERE Resource Consultants

December 2005

Figure 3-12

Twin Falls Canal Company Claimed Irrigated Lands Within Permitted Groundwater Places of Use



Source: IWWRI, 2005a, http://www.if.uidaho.edu/~johnson/ifiwrri/projects.html

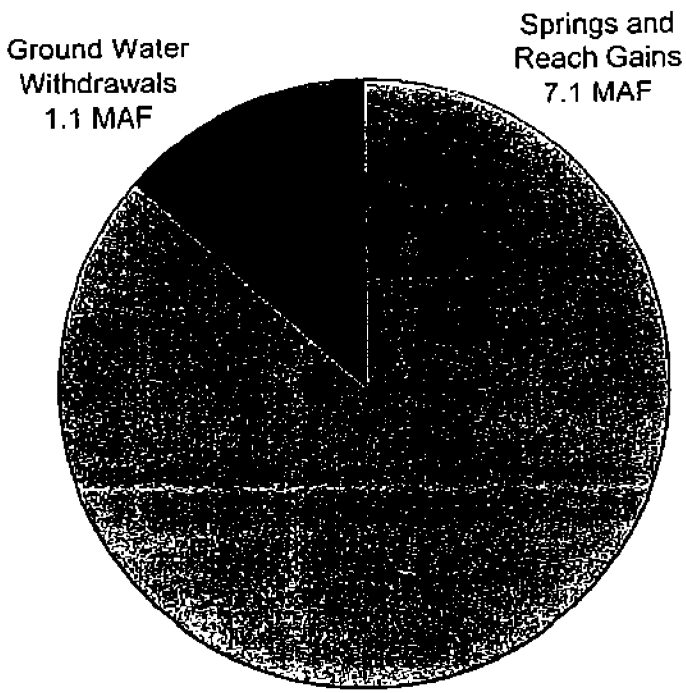
HYDROSPHERE Resource Consultants

December, 2005

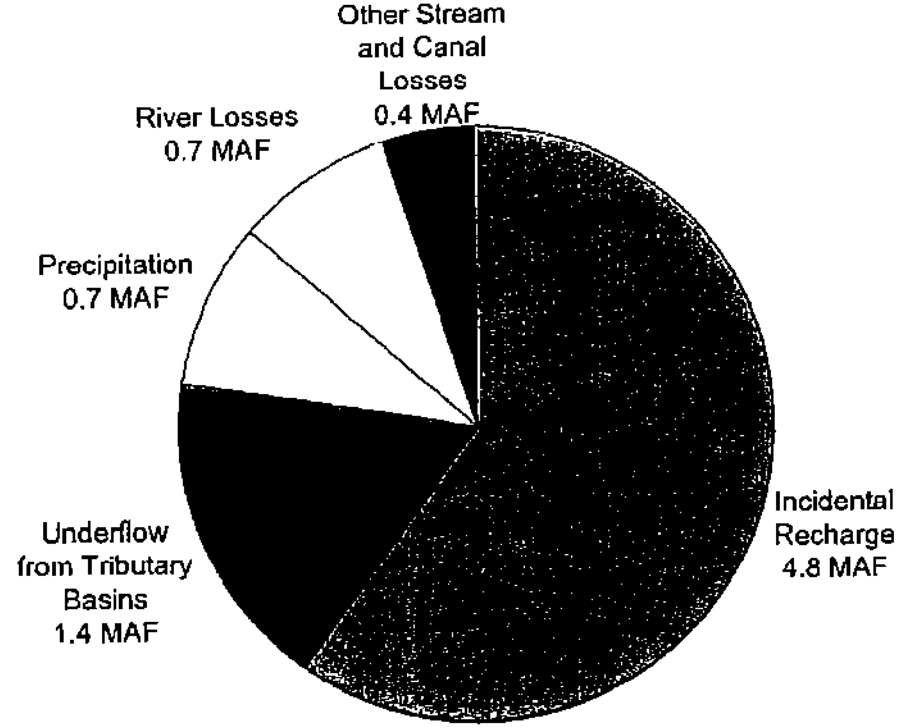
Figure 4-1

ESPA Model Grid and Hydraulic Boundary Conditions

1980 Discharge



1980 Recharge



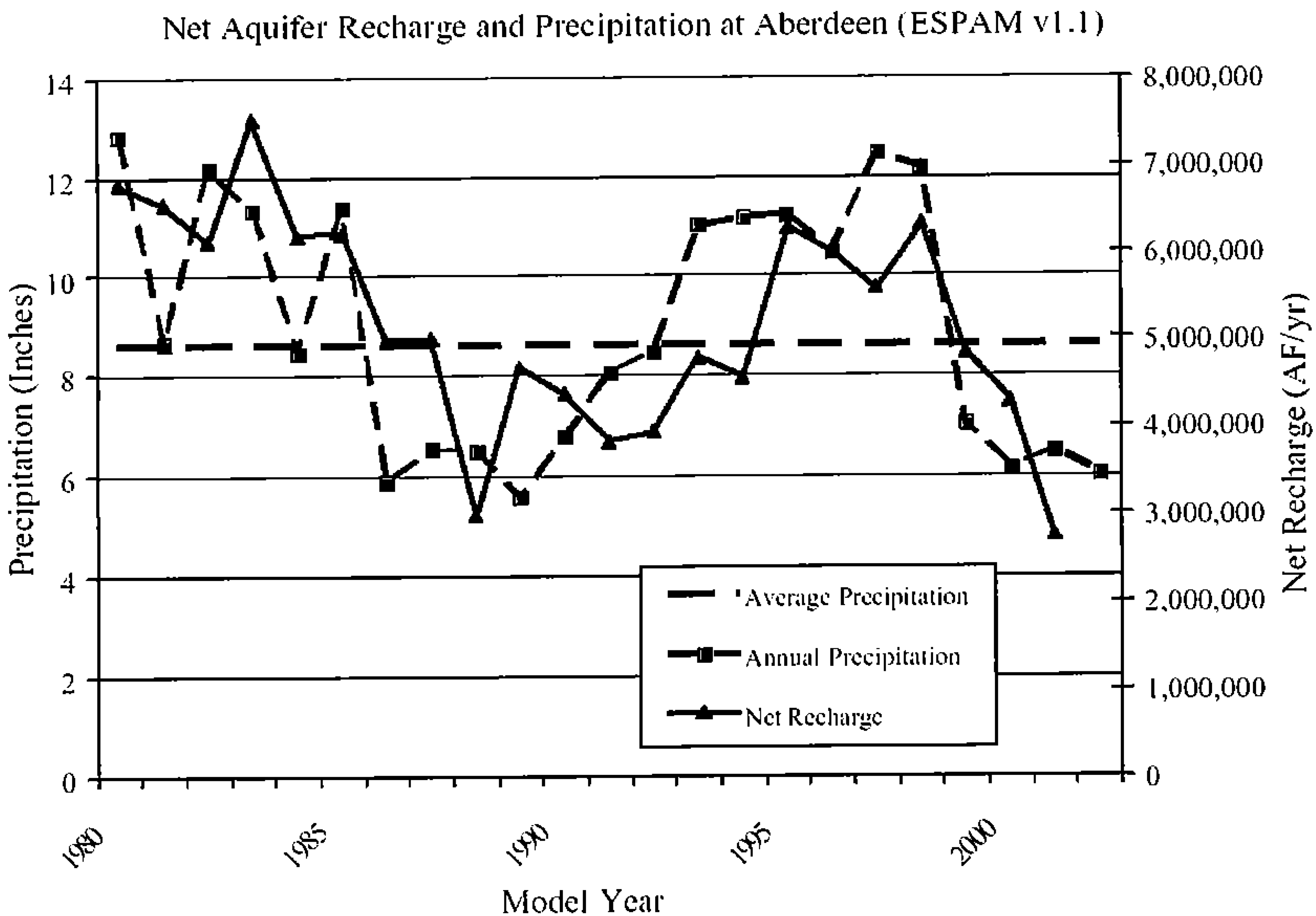
Source: Lindholm, 1996

HYDROSPHERE
Resource Consultants

December 2005

Figure 4-2

Groundwater Budget ESPA Water Year Recharge and Discharge for 1980



Source: IWRRI, 2005b, http://www.if.uidaho.edu/%7ejohnson/BaseCase_Final_v1-1_mod.pdf, p. 8

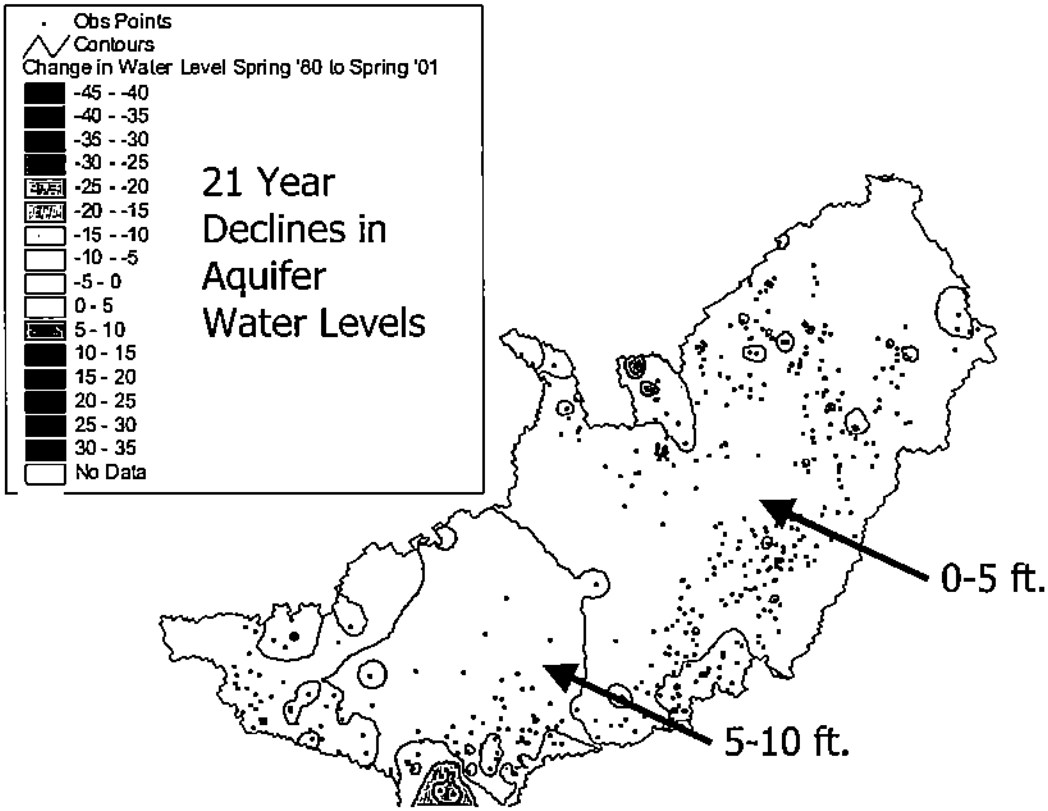
HYDROSPHERE Resource Consultants

December, 2005

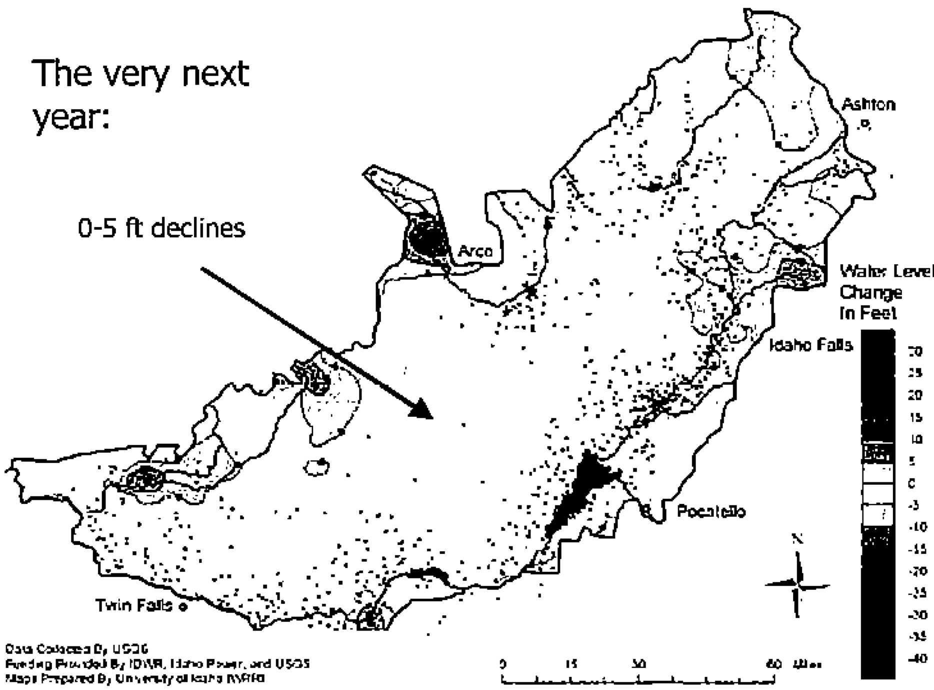
Figure 4-3

Importance of Precipitation to Aquifer Recharge

Spring 1980 to Spring 2001 Water Level Change Map



Spring 2001 to Spring 2002 Water Level Change Map



Source: Cosgrove Presentation to Legislative Subcommittee, August 5, 2004

HYDROSPHERE Resource Consultants December, 2005	Figure 4-4 **Aquifer Water Level Change – 1980-2001 and 2001 - 2002**

Simulation Results for the Near Blackfoot to Neeley Reach (ESPAM v1.1)

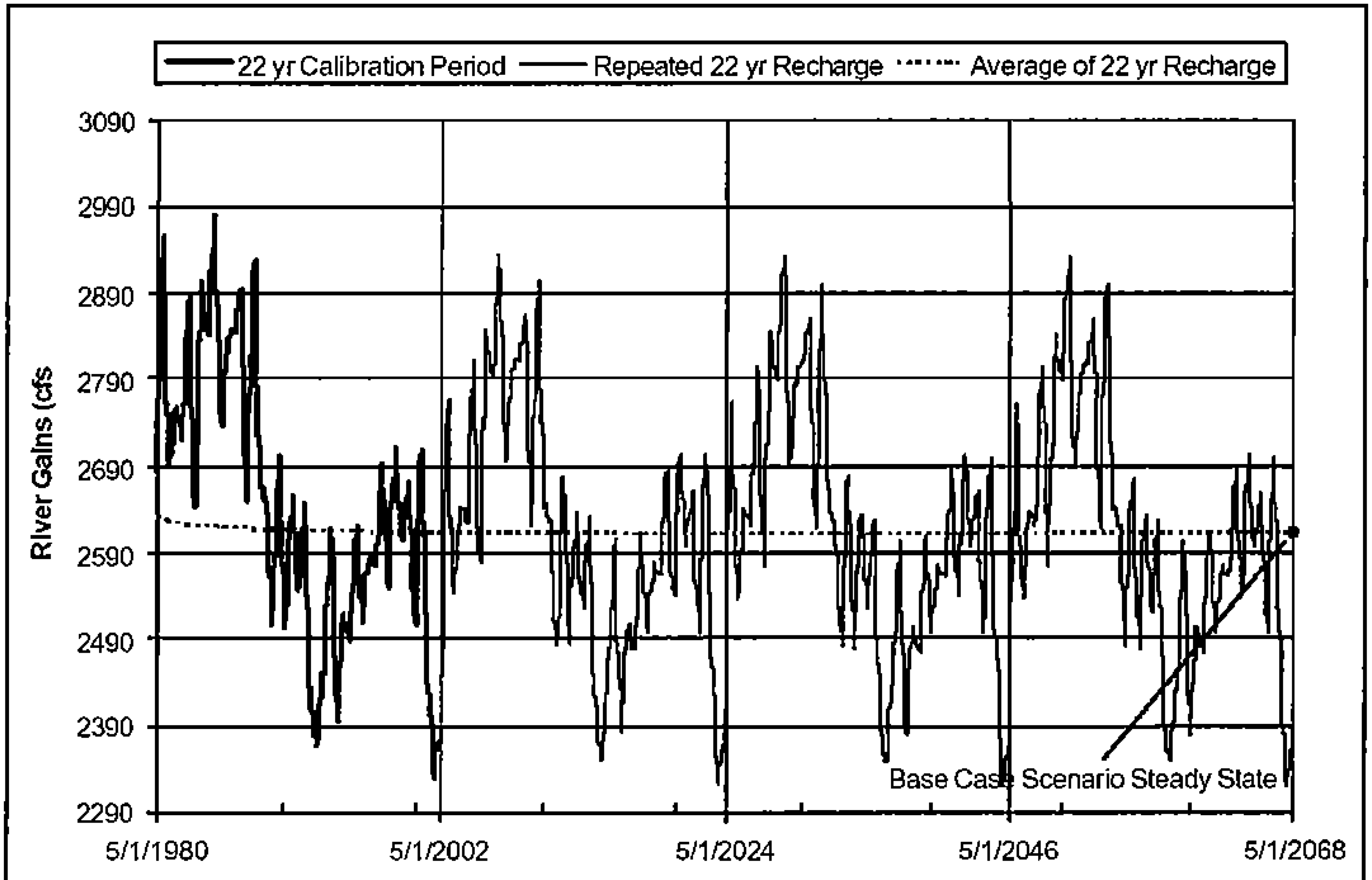


Figure 9. Simulation Results for the near Blackfoot to Neeley Reach (ESPAM v1.1)

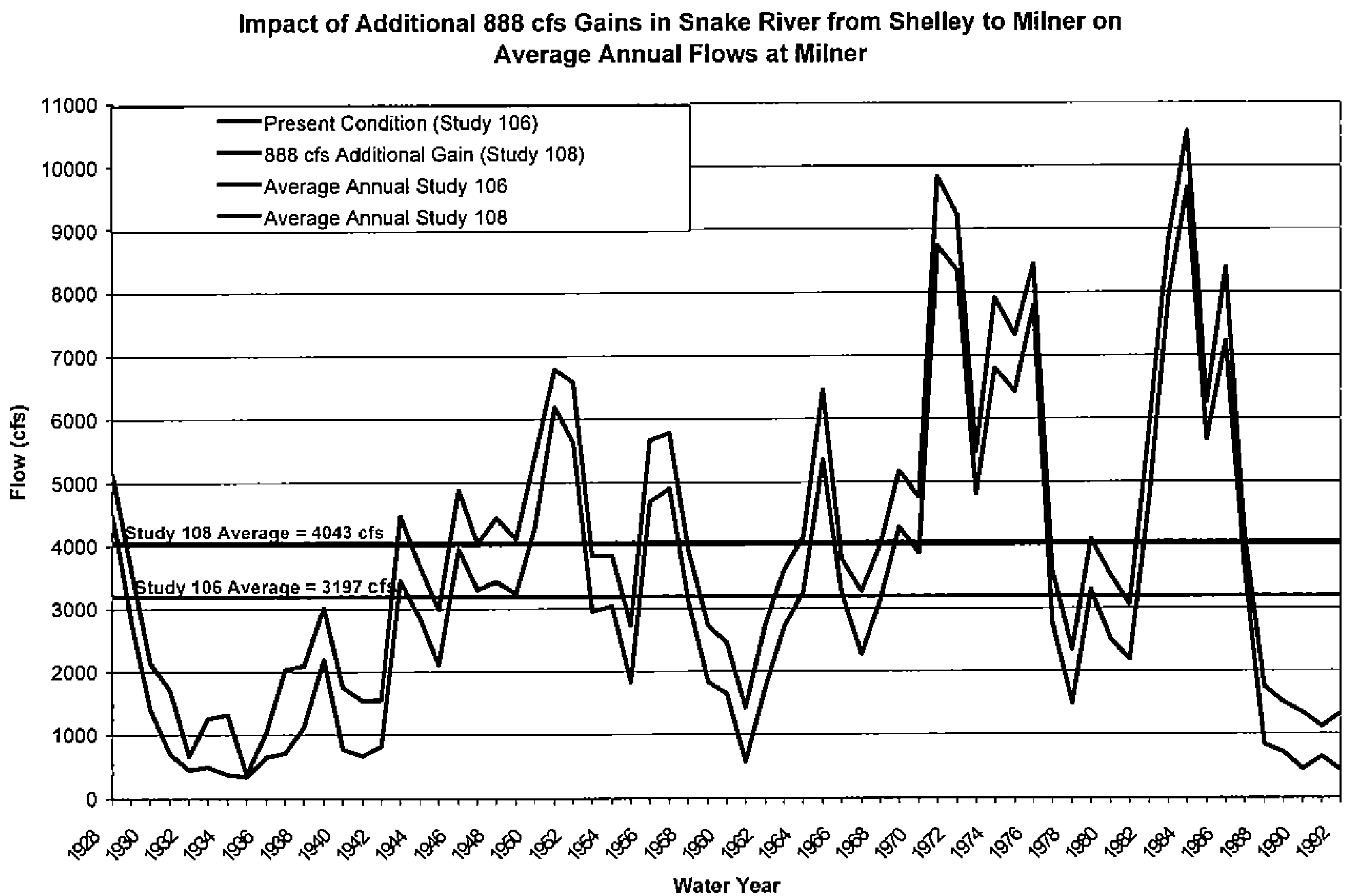
Source: IWRRI, 2005b, http://www.if.uidaho.edu/%7ejohnson/BaseCase_Final_v1-1_mod.pdf, p. 13

HYDROSPHERE Resource Consultants

December, 2005

Figure 4-5

Simulation Results for the Near Blackfoot to Neeley Reach (ESPAM v1.1)



Source: IDWR, "Study108_888cfs_HDR.zip", ftp://ftp.state.id.us/IDWR/Outgoing/SWCoalition/

HYDROSPHERE Resource Consultants

December 2005

Figure 4-6

Disposition of Reach Gain from 1961 Curtailment, IDWR Study

Principal Irrigation Water Storage Reservoirs Above Milner

Name of Dam/Reservoir	Project Name	Location	Date Operation Began	Current Capacity KAF
Jackson Lake*	Minidoka	Snake River	1906	847
Minidoka*	Minidoka	Snake River	1906	95
Magic	private	Big Wood River	1909	191
Blackfoot	Blackfoot	Blackfoot River	1910	313
Henry's Lake	private	Henry's Fork	1922	90
American Falls*	Minidoka	Snake River	1926	1673
Island Park	Minidoka	Henry's Fork	1938	135
Grassy Lake	Minidoka	Grassy Creek	1939	15
Palisades*	Palisades	Snake River	1956	1200
Ririe	Ririe	Willow Creek	1975	91

** denotes supply reservoir accessible to SWC entities*

Source: Water & Power Resources Service, 1981
US Army Corps of Engineers, 1985

Monthly Flows at Montgomery Ferry, 1896 - 1910 (CFS)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Average
1896	4,619	4,806	4,781	4,798	5,336	5,578	5,882	12,132	53,777	17,076	5,708	4,974	10,789
1897	4,960	4,823	4,798	4,407	4,355	4,407	6,571	33,014	30,250	10,717	5,220	4,974	9,875
1898	4,993	5,193	4,798	4,196	4,961	5,546	8,638	17,727	21,007	8,912	3,318	3,647	7,745
1899	5,074	5,378	4,700	4,798	4,872	5,416	6,201	13,710	29,073	26,184	8,766	6,016	10,016
1900	6,001	6,504	6,001	5,806	5,961	6,196	7,999	17,239	16,503	4,619	2,797	3,496	7,427
1901	4,700	4,907	4,798	4,505	4,551	4,993	5,999	20,980	14,116	4,651	2,114	2,840	6,596
1902	4,131	4,739	4,700	4,424	4,426	4,440	5,109	11,791	17,982	6,896	2,423	2,622	6,140
1903	4,017	5,092	5,042	4,798	4,765	5,302	7,025	10,165	19,830	9,677	3,220	3,899	6,902
1904	5,546	5,915	5,725	5,204	5,497	6,538	7,798	24,557	28,233	12,978	4,879	5,579	9,871
1905	5,773	6,084	5,838	5,806	5,497	5,643	5,781	8,928	10,907	4,554	1,984	1,949	5,729
1906	3,415	4,487	4,554	4,098	4,390	5,139	7,159	14,507	21,007	8,880	2,895	3,781	7,026
1907	5,155	4,605	4,798	4,798	3,998	6,180	12,100	21,793	29,073	22,118	7,497	6,201	10,693
1908	7,091	7,378	7,335	6,196	6,228	7,839	8,100	11,303	21,343	10,099	4,554	5,512	8,581
1909	6,896	6,907	5,985	7,205	6,675	6,375	7,176	15,694	32,770	19,516	7,741	9,277	11,018
1910	7,221	8,134	7,302	5,806	5,515	10,994	16,099	20,980	10,402	4,538	2,291	3,110	8,533
Average	5,306	5,663	5,410	5,123	5,135	6,039	7,842	16,968	23,752	11,428	4,361	4,525	8,463
Minimum	3,415	4,487	4,554	4,098	3,998	4,407	5,109	8,928	10,402	4,538	1,984	1,949	5,729
Maximum	7,221	8,134	7,335	7,205	6,675	10,994	16,099	33,014	53,777	26,184	8,766	9,277	11,018

Source: USGS, 1950

HYDROSPHERE
Resource Consultants

December, 2005

Table 3-1

Monthly Flows at Montgomery Ferry, 1896 - 1910

Surface Water Coalition Natural Flow Water Rights (1,2)
Sorted by Priority Date

Canal/District	Amount(cfs)	Priority Date	Cumulative Amount (cfs)
North Side Canal Company	400	10 11 1900	400
Twin Falls Canal Company	3000	10 11 1900	3400
Minidoka Irrigation District(3)	1726	3 26 1903	5126
North Side Canal Company	2250	10 7 1905	7376
North Side Canal Company	350	6 16 1908	7726
Minidoka Irrigation District(3)	1000	8 6 1908	8726
Twin Falls Canal Company	600	12 22 1915	9326
North Side Canal Company	300	12 23 1915	9626
Milner Irrigation District	135	11 14 1916	9761
North Side Canal Company	1260	8 6 1920	11021
Am. Falls Res District #2	850	3 30 1921	11871
Am. Falls Res District #2	1700	4 1 1921	13571
Minidoka Irrigation District(3)	430	4 1 1939	14001
A&B Irrigation District	267	4 1 1939	14268
Milner Irrigation District	121	4 1 1939	14389
Twin Falls Canal Company	180	4 1 1939	14569
Milner Irrigation District	37	10 25 1939	14606

Notes: (1) For irrigation use
(2) From May 2 Order, District 01
(3) Water rights shared with Burley Irrigation District

Mainstem Reservoir Water Rights* and SWC Spaceholder Contracts

Reservoir	Priority Date	Amount (acre-feet)	Spaceholders	Amounts (af)
Jackson Lake	8/23/1906	298,981	Minidoka ID	127,040
	8/18/1910	138,829	Minidoka ID	58,990
			North Side CC	312,007
	5/24/1913	409,190	Twin Falls CC	97,183
		847,000	Others	247,948
			Uncontracted (B.O.R.)	3,832
				847,000
Palisades	03/29/1921**	259,600	Minidoka ID	5,328
	7/28/1939	940,400	Burley ID	2,672
		1,200,000	North Side CC	116,600
			Minidoka ID	29,672
			Burley ID	36,528
			A&B ID	90,800
			Milner ID	44,500
			Others	863,878
			Uncontracted (B.O.R.)	10,022
				1,200,000
American Falls	03/29/1921**	156,830	North Side CC	9,248
	3/31/1921	1,515,760	Twin Falls CC	147,582
		1,672,590	Minidoka ID	82,216
			Burley ID	155,395
			A&B ID	46,826
			Milner ID	44,951
			AFRD#2	393,550
			North Side CC	422,043
			Twin Falls CC	1,165
			Others	360,573
			Uncontracted (B.O.R.)	9,041
				1,672,590
Lake Walcott	12/14/1909	95,200	Minidoka ID	63,308
			Burley ID	31,892
				95,200

* Assuming no space designated as last-to-fill.
** Winter Water Savings Program fill priority is ahead of main reservoir storage right.

Source: Water District 01

HYDROSPHERE Resource Consultants

December, 2005

Table 3.3

Surface Water Coalition (SWC) Storage Water Rights

Reliability of SWC Storage Supplies

Space Owned (AF):	Minidoka ID	Burley ID	A&B ID	Milner ID	AFRD #2	North Side	Twin Falls	All SWC Contract Holders
	366,544	226,487	137,626	90,591	393,550	859,898	245,930	
Water Year	Percent of Contracted Space Used							
1960	82%	84%	83%	76%	102%	93%	101%	91%
1961	73%	74%	73%	67%	65%	62%	81%	68%
1962	82%	85%	94%	78%	102%	95%	101%	93%
1963	83%	87%	101%	81%	102%	96%	101%	94%
1964	83%	87%	101%	81%	102%	96%	101%	94%
1965	83%	87%	101%	100%	102%	96%	101%	95%
1966	82%	85%	91%	93%	102%	94%	101%	93%
1967	83%	87%	101%	100%	102%	96%	101%	95%
1968	83%	86%	97%	97%	102%	95%	101%	94%
1969	81%	83%	85%	88%	102%	93%	101%	92%
1970	83%	87%	101%	100%	102%	96%	101%	95%
1971	83%	87%	101%	100%	102%	96%	101%	95%
1972	82%	85%	93%	94%	102%	103%	101%	96%
1973	75%	62%	84%	79%	67%	79%	80%	75%
1974	75%	63%	89%	82%	68%	80%	80%	76%
1975	75%	63%	89%	82%	68%	80%	80%	76%
1976	73%	58%	74%	71%	65%	77%	79%	72%
1977	67%	63%	89%	82%	68%	67%	65%	68%
1978	69%	86%	82%	97%	102%	90%	91%	88%
1979	89%	89%	91%	94%	102%	89%	66%	89%
1980	88%	88%	99%	98%	99%	90%	89%	92%
1981	91%	90%	99%	97%	99%	93%	93%	94%
1982	90%	89%	99%	98%	100%	90%	89%	92%
1983	90%	89%	99%	98%	100%	90%	89%	92%
1984	90%	89%	99%	98%	100%	90%	89%	92%
1985	76%	76%	99%	97%	99%	75%	73%	82%
1986	79%	78%	99%	98%	99%	74%	75%	82%
1987	75%	74%	98%	97%	98%	75%	73%	81%
1988	73%	72%	69%	97%	98%	75%	73%	79%
1989	90%	81%	76%	96%	98%	99%	99%	94%
1990	87%	91%	88%	93%	99%	99%	99%	95%
1991	91%	95%	98%	91%	99%	99%	99%	97%
1992	71%	94%	94%	90%	98%	88%	85%	88%
1993	98%	98%	99%	98%	100%	93%	92%	96%
1994	97%	98%	99%	97%	99%	98%	98%	98%
1995	97%	97%	98%	99%	99%	99%	99%	99%
1996	96%	97%	98%	98%	99%	99%	99%	98%
1997	97%	97%	99%	99%	99%	99%	100%	99%
1998	97%	97%	99%	99%	99%	99%	100%	99%
1999	96%	97%	94%	95%	98%	96%	97%	97%
2000	94%	97%	96%	96%	97%	95%	95%	95%
2001	93%	94%	89%	98%	98%	89%	85%	92%
2002	85%	94%	40%	78%	98%	83%	87%	84%
2003	89%	96%	40%	64%	97%	91%	96%	89%
2004	85%	90%	33%	46%	80%	75%	61%	74%
Average	85%	85%	89%	90%	95%	90%	90%	89%

Source: (proper citation here)

Water Bank Activity in Acre-feet

Consigned to Bank(+), Leased from Bank(-)

Irrigation Year	Minidoka ID	Burley ID	A&B ID	Milner ID	AFRD #2	North Side	Twin Falls	Total Leased
1960	0	0	0	-10700	0	0	1000	10700
1961	0	0	0	-100	0	0	0	100
1962	0	0	0	-1760	0	0	0	1760
1963	0	0	0	-3560	0	0	0	3560
1964	0	0	0	-1460	0	0	0	1460
1965	0	0	0	-1360	0	0	0	1360
1966	0	0	0	-2660	-48600	0	0	51260
1967	0	0	0	-1360	0	0	0	1360
1968	0	0	0	-1860	0	0	0	1860
1969	0	0	0	0	0	0	0	0
1970	0	0	0	-1320	0	0	0	1320
1971	0	0	0	-820	0	0	0	820
1972	0	0	0	-820	0	0	0	820
1973	0	0	0	0	-56577	0	0	56577
1974	0	0	0	-1450	0	0	0	1450
1975	0	0	0	-1450	0	0	0	1450
1976	0	0	-1450	0	0	0	0	1450
1977	0	0	-43108	0	0	-8346	0	51454
1978	0	0	0	0	0	0	0	0
1979	0	10000	0	0	0	0	60000	0
1980	0	0	0	-1452	0	0	49581	1452
1981	50000	0	50000	-1450	0	0	20000	1700
1982	75000	0	50000	-1500	0	0	50000	1750
1983	150000	0	75000	3500	0	50000	100000	250
1984	350000	0	75000	8500	0	50000	70000	0
1985	95000	0	75000	-1500	0	0	27694	1500
1986	200000	0	0	13500	0	60000	80000	0
1987	90000	0	75000	-2000	0	0	0	2000
1988	90000	0	27000	-2300	0	-32526	0	34826
1989	80000	100000	30000	14077	-225	0	0	225
1990	75000	60000	0	-1359	-1743	0	0	3102
1991	50000	0	0	-7980	-2583	0	0	10563
1992	0	0	0	-494	0	0	0	494
1993	0	0	0	6201	-345	0	0	345
1994	0	-4000	0	-6199	-330	0	-20000	30529
1995	25000	19700	25000	-12207	-225	20000	5000	12432
1996	25000	25183	20000	-9398	-20231	48353	-3757	33386
1997	50000	46472	20000	-6366	0	0	-800	7166
1998	50000	50000	20000	-794	-8404	0	-500	9698
1999	50000	0	20000	-7762	-11133	-446	-500	19841
2000	10000	12000	20000	-1625	-160	0	-4000	5785
2001	0	0	0	0	0	0	0	0
2002	-651	-1738	3000	-1131	-362	-13130	-15189	32201
2003	23777	9136	-17	-2463	-345	-3458	-15071	21354
2004	0	0	0	0	-1202	0	-19228	20430
Avg	34181	7261	12009	-1175	-3388	3788	8538	9773
Min	-651	-4000	-43108	-12207	-56577	-32526	-20000	

Notes:

1 *Consignments may not include private agreements.*

2 *Water Bank was not formalized until 1980, so data prior may be incomplete*

Source: Water District 36 and 01 Accounting Reports

Year	A & B Irrigation District	Milner Irrigation District	Twin Falls Canal Company	American Falls Reservoir District #2	North Side Canal Company	
	Acre-Feet	Acre-Feet Per Acre	Inches Per Acre	Inches Per Acre	Inches Per Acre	
					1st Segregation	2nd & 3rd Segregation
1990	48,187.0	3.31	3/4	5/8	5/8	5/8
1991	43,634.9	2.77	3/4	5/8	5/8	5/8
1992	51,083.7	2.98	3/4, 5/8, 1/2	1/2	5/8	1/2, 0.464, 7/16
1993	42,294.0	2.64	3/4	5/8,1/2	5/8	7/16, 5/8
1994	49,509.6	2.79	3/4, 5/8	1/2	5/8	5/8, 1/2
1995	41,673.8	2.19	3/4	5/8	5/8	5/8
1996	48,248.1	2.83	3/4	5/8	5/8	5/8
1997	44,005.4	3.02	3/4	5/8	5/8	5/8
1998	42,732.4	2.68	3/4	5/8	5/8	5/8
1999	43,903.7	2.72	3/4	5/8	5/8	5/8
2000	52,183.4	3.12	3/4	5/8	5/8	5/8
2001	52,176.6	3.04	3/4, 5/8, 1/2	1/2	5/8	1/2
2002	46,780.4	2.88	3/4, 5/8	1/2	5/8	3/8, 2/5, 0.54
2003	49,355.8	3.00	5/8	1/2	5/8	1/2
2004	41,421.8	2.17	5/8, 1/2	1/2*	5/8	7/16

* Shut Down 5/25 to 6/04

Source: SWC Information Submittal of 3/15/05

HYDROSPHERE Resource Consultants

December, 2005

Table 3-6

Canal Company Annual Headgate Diversions

Reach gains with cutoff date January 1, 1870

Reach Name	Irrigation Season (AF)	Full First Year (AF)	Steady State (AF)
Near Blackfoot to Neeley	107,883	213,511	749,491
Neeley to Minidoka	3,201	8,689	114,438
Subtotal above Milner	165,147	353,976	1,538,887
Total of all reaches	240,377	464,878	1,985,928

2005 Injury Thresholds and Projected Material Injury

Entity	Minimum Full Supply May 2 Order acre-feet	Reasonable Carryover May 2 Order acre-feet	Predicted 2005 Material Injury May 2 Order acre-feet
Minidoka Irr Dist (North Side)	280,200	0	0
Burley Irr Dist (South Side)	254,300	0	0
A & B Irr Dist	50,000	8,500	13,400
American Falls Res Dist #2	405,600	51,200	68,700
Milner Irr Dist	50,800	7,200	3,100
North Side Canal Co	988,200	83,300	4,500
Twin Falls Canal Co	1,075,900	38,400	43,700

Source: Director's Order of May 2, 2005

Table 5-1

Injury Thresholds and Projected Material Injury

Summary of Historical Mitigation Activity Below Milner

Mitigation Activity	Year Undertaken	Gross Amount of Water Involved (AF)
Sandy Pipeline deliveries	2003	9,000
	2004	12,814
	2005*	12,814
Pumping Reductions	2002	30,277
Conversions	2002	19,963
	2003	27,000
	2004	31,137
	2005*	31,137
Curtailment	2004	3000 acres
	2005*	10%
Targeted recharge	2005*	1,600

* Projected values for 2005

Summary of 2005 Reach Gain Benefits, Blackfoot-Milner

Pre-2005 Sandy Pipeline, Pumping Reductions, and Conversions in 130		1,297
2005 Sandy Pipeline and Conversions in 130		2
2005 Curtailment of 10% in 130		65
2005 Targeted recharge of 1600 af in 130		3
	Total	1,407

2005 Replacement Water Sources Above Milner

Source	Acre-Feet
FMC Lease	6,820
New Sweden Irr. Dist.	15,000
Peoples Canal Co.	3,000
Snake River Valley Irr. Dist.	2,000
Grindstone-Butte, et al. (High-lift exchange)	47,970*
United Water Idaho (High-lift exchange)	9,833**
Subtotal – Surface water supplies	84,623
WD 120 Dry-Year Leasing	2,522***
	87,145

* Based on total 2005 lease of 58,500 AF at 82% exchange credit from USBOR. Letter of intent has been executed between Ground Water Districts and Lessors. Exchange Agreement with USBOR is pending.

** Based on total 2005 lease of 11,992 AF at 82% exchange credit from USBOR. Execution of lease agreement with Lessor and exchange agreement with USBOR are pending.

*** Eight separate dry-year lease agreements affecting 1,261 total acres in Bingham and Power Counties have been executed. Total associated consumptive use foregone in 2005 is 6,828 AF. First year reach gain increase in Blackfoot to Milner reach is 520 AF. Second year reach gain increase is 344 AF.

HYDROSPHERE
Resource Consultants
December, 2005

Table 5-2

IGWA Replacement Water Plan Summary